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United States
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Agriculture

Forest Service

Forest Pest
Management

Davis, CA

SUPPLEMENT TO SIXTH REPORT

NATIONAL STEERING COMMITTEE FOR MANAGEMENT OF GYPSY MOTH AND EASTERN DEFOLIATORS - USDA APHIS PESTICIDE EVALUATION REPORTS

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FPM 94-3
December 1993

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Pesticides used improperly can be injurious to human beings, animals, and plants. Follow the directions and heed all precautions on labels. Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides where there is danger of drift when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment, if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S Environmental Protection Agency, consult your local forest pathologist, county agriculture agent, or State extension specialist to be sure the intended use is still registered.

FPM 94-3
December 1993

Supplement to Sixth Report

National Steering Committee for Management of Gypsy Moth and Eastern Defoliators - USDA APHIS Pesticide Evaluation Reports

Prepared by:

John W. Barry
Chairperson

USDA Forest Service
Forest Pest Management
2121C Second Street
Davis, CA 95616
(916)551-1715
FAX (916)757-8383

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Preface

The papers included in the supplement to the Sixth Report National Steering Committee for Management of Gypsy Moth and Eastern Defoliators were provided by Win McLean, Section Leader, Insecticide and Application Technology Section, USDA Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Otis Methods Development Center, Bldg. 1398, Otis ANGB, Massachusetts 02542-5008. (508) 563-9303, fax (508) 564-4398.

The purpose of this supplement is to provide information to committee members and their associates on results and progress in screening and testing adjuvants insecticides, and biorational materials for control of gypsy moth and eastern defoliators.

Laboratory Screening of Candidate Pesticides
July - December, 1974

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Project Number: GM 5.1.1
Project Title: Laboratory Screening of Candidate Pesticides
Report Period: July - December, 1974
Report Type: Interim
Project Leader: Winfred H. McLane

The main objective of this laboratory screening project is to collect mortality data on experimental compounds potentially useful against the gypsy moth, evaluating the data and selecting suitable materials for field testing.

Circular tin dishes 3.75 X 0.5" were sprayed at 1 lb. AI/gal/ac in replicates of 5 with 2nd instar gypsy moth larvae used as test insects. Five larvae were allowed to crawl over the treated surface of each dish for given periods of time. Larvae were then removed and held on artificial diet with mortality readings being taken at various times. Results are tabulated below.

Material	Exposure	Hours After Treatment Larvae Exposed	Hours	Mortality %
DDT 50 W/P	5 min	1	23	4
"	"	4	27	16
"	"	7	20	40
"	"	24	2.5	28
Sevin 80S	5 min	1	30	44
"	"	4	27	88
"	"	7	20	68
Resmethrin EC	5 min	1	23	84
"	"	4	27	92
"	"	7	20	100
Check	5 min	1	30	0
DDT 50 W/P	1 hour	1	24	32
"	2 "	2.5	25	84
"	3 "	4.5	42	96
"	17.5 "	8	25	76
"	7 "	0.5	16	44
Sevin 80S	1 hour	1	24	96
"	2 "	2.5	21	100
"	3 "	4.5	42	92
"	17.5 "	8	25	100
"	7 "	0.5	16	96
Resmethrin EC	1 hour	1	24	100
"	2 "	2.5	21	96
"	3 "	4.5	42	100
"	17.5 "	8	25	76
"	7 "	0.5	16	100
Check	17.5 "	1	42	0

CGA-18809, Imidan and TH-6040 wettable powders were mixed with H_2O and allowed to age for 5 days at 80° and 60% humidity. After this period tender oak seedlings were sprayed and 2nd instar larvae were then introduced onto plants.

			Mortality %			
Material	Dosage	Days Aged	24 H	48 H	72 H	96 H
CGA-18809	0.25 lb/gal/ac	0	32	70	99	
"	0.125 lb/gal/ac	0	25	95	100	
"	0.25 lb/gal/ac	5	15	73	100	
"	0.125 lb/gal/ac	5	18	76	100	
Imidan	1.0 lb/gal/ac	0	94	100		
"	0.5 lb/gal/ac	0	44	100		
"	1.0 lb/gal/ac	5	16	82	99	100
"	0.5 lb/gal/ac	5	13	71	99	99
TH-6040	0.03 lb/gal/ac	0	0	0	4	9
"	0.015 lb/gal/ac	0	0	0	2	4
"	0.03 lb/gal/ac	5	0	3	64	85
"	0.015 lb/gal/ac	5	0	4	52	90
Check	-	-	0	0	0	0

Little if any effectiveness was lost with CGA-18809 or Imidan. TH-6040 appeared to gain strength, however, this in part may have been due to the age of 2nd instar test insects.

A field sample of encapsulated Diazinon was tested in the laboratory and gave good mortality for 3 weeks. This same material performed poorly in the field.

Encapsulated Dibrom was tested at various dosages with results being poor.

SAN I 197 and SAN I 201, organo phosphates from Sandoz Inc., gave excellent control of 2nd instar gypsy moth larvae when tested on oak seedlings at 0.0625 lb AI/gal/ac. When exposed to 3" of rainfall materials continued to give good kill. The acute oral LD 50 of SAN I 197 and SAN 201 to male rats is 1800 and 3120 mg/kg respectively.

			Mortality %			
Material	Dosage	Rain	24 H	48 H	72 H	96 H
SAN I 197	2 lb AI/gal/ac	-	87	99	100	
"	1 "	-	86	100		
"	0.5 "	-	70	97	100	
"	0.25 "	-	50	94	100	
"	0.125 "	-	41	93	100	

Material	Dosage	Rain	Mortality % 24 H	48 H	72 H	96 H
SAN I 197	0.062 lb AI/gal/ac	-	14	38	63	
"	0.031 "	-	6	15	18	
"	0.0156 "	-	8	22	41	
"	0.0078 "	-	4	19	25	
Check	-	-	0	0	0	
SAN I 197	1 lb AI/gal/ac	1"	87	98	100	
"	0.5 "	"	74	97	100	
"	0.25 "	"	64	78	97	
"	0.125 "	"	42	57	85	
"	0.062 "	"	36	54	71	
Check	-	-	0	0	0	
SAN I 197	1 lb AI/gal/ac	3"	57	80	86	89
"	0.5 "	"	51	84	97	99
"	0.25 "	"	23	29	42	60
"	0.125 "	"	42	52	81	92
"	0.062 "	"	26	45	64	80
Check	-	-	0	0	0	0
SAN I 201	2 lb AI/gal/ac	-	83	100		
"	1 "	-	79	100		
"	0.5 "	-	66	99	100	
"	0.25 "	-	57	97	100	
"	0.125 "	-	40	97	100	
"	0.062 "	-	46	83	100	
"	0.031 "	-	15	41	86	
"	0.015 "	-	3	4	9	
"	0.007 "	-	2	2	13	
Check	-	-	0	0	0	
SAN I 201	1 lb AI/gal/ac	1"	64	92	99	
"	0.5 "	"	60	87	97	
"	0.25 "	"	52	75	98	
"	0.12 "	"	39	69	91	
"	0.06 "	"	29	43	54	
Check	-	-	0	0	0	
SAN I 201	1 lb AI/gal/ac	3"	49	94		
"	0.5 "	"	46	96		
"	0.25 "	"	37	83		
"	0.12 "	"	19	64		
"	0.06 "	"	22	56		
Control	-	-	0	0		

The following materials were tested against 2nd instar larvae on treated tender oak seedlings.

Material	Dosage lb/gal/ac	Percent Mortality
DS-24465 (Diamond Shamrock)	1.0	100 (4 days)
	0.5	95
	0.25	92
	0.125	86
	0.062	85
	0.031	25
	0.015	3
	0.007	0
	0.003	1
	Check	0
ACD-7029 (Allied Chemical)	1.0	44 (3 days)
	0.5	67
	0.25	51
	0.125	18
	0.062	11
	Check	2
GC-9160 (Allied Chemical)	1.0	38 (3 days)
	0.5	4
	0.25	6
	0.125	1
	0.062	0
	Check	0
GC-S-10200 (Allied Chemical)	1.0	3 (3 days)
	0.5	1
	0.25	0
	0.12	3
	0.06	0
	Check	0
Gulf 15126	1.0	96 (3 days)
	0.5	97
	0.25	98
	0.125	99
	0.062	95
	0.031	83
	0.015	61
	0.007	23
	0.003	17
	Check	0

Material	Dosage lb/gal/ac	Percent Mortality
Buson 30 (Buckman Laboratory)	1.0	8 (4 days)
	0.5	3
	0.25	4
	0.125	5
	0.06	4
	Check	0
Vineland B	1.0	1 (4 days)
	0.5	3
	0.25	0
	Check	0
GC-10101	1.0	9 (4 days)
	0.5	5
	0.25	0
	Check	0
GC-10284	1.0	94 (3 days)
	0.5	85
	0.25	75
	0.12	34
	0.06	21
	Check	0
SAN-197 (In Water)	1.0	100 (2 days)
	0.5	100 (4 days)
	0.25	100 (4 days)
	0.125	100 (4 days)
	0.062	63 (4 days)
SAN-197 (In Kerosene)	1.0	100 (2 days)
	0.5	99 (4 days)
	0.25	97 (4 days)
	0.125	95 (4 days)
	0.062	89 (4 days)
	Check	0 (4 days)

Material - SAN I-197

Dosage lb/gal/ac	Rain	Sticker	Percent Mortality
1	1"	-	100 (72 hrs)
"	3"	-	86 (72 hrs)
"	1"	3% Chevron	100 (96 hrs)
"	1"	3% Pinolene 1902	100 (96 hrs)
0.5	1"	-	100 (72 hrs)
"	3"	-	97 (72 hrs)
"	1"	3% Chevron	100 (96 hrs)
"	1"	3% Pinolene 1902	100 (96 hrs)
0.25	1"	-	97 (72 hrs)
"	3"	-	42 (72 hrs)
0.125	1"	-	85 (72 hrs)
"	3"	-	81 (72 hrs)
"	1"	3% Chevron	93 (96 hrs)
"	1"	3% Pinolene Nufilm	99 (96 hrs)
"	1"	6% Chevron	87 (96 hrs)
"	1"	6% Pinolene Nufilm	100 (96 hrs)

Material - Gulf 51526 E 15, Aged 23 days

lb/gal/ac	Percent Mortality After 5 Days
0.25	100
0.125	100
0.062	100
0.031	96
0.015	6

Based on prior field tests and laboratory data, the following materials will be field tested during 1975 using aerial application.

TH-6040	0.065 lb/gal/ac	150 acres
TH-6040	0.015 lb/gal/ac	150 acres
CGA-18809	0.5 lb/gal/ac	150 acres
CGA-18809	0.125 lb/gal/ac	150 acres
S-15126	0.5 lb/gal/ac	150 acres
S-15126	0.125 lb/gal/ac	150 acres
SAN I-197	0.20 lb/gal/ac	150 acres
SAN I-197	0.06 lb/gal/ac	150 acres
Sevin 4 Oil (Standard)	1.0 lb/40 oz/ac	150 acres

Ground applications will be made with the following materials.

ABG-6010	SAN I-197
CGA-18809	SBP-1513
Dipel	Sevin 805
FMC-33297	S-1S126
NTN-8629	TH-6040

Laboratory Screening of Candidate Pesticides
January - June, 1975

Project Number: GM 5.1.1
Project Title: Laboratory Screening of Candidate Pesticides
Report Period: January - June, 1975
Report Type: Interim
Project Leaders: Winfred H. McLane and Joyce A. Finney

The main objective of this laboratory screening project is to collect mortality data on experimental compounds potentially useful against the gypsy moth, evaluating the data a selecting suitable materials for field testing.

The following materials were tested against 2nd instar larvae on treated tender oak seedlings.

Material	Dosage lb/gal/A	Weather	Aging	Percent Mortality
Actellic (ICI America Inc.)	1.0			98 (3 days)
	0.5			99
	0.25			86
	0.125			58
	0.062			3
	Check			0
AC-206,769 (American Cyanamid)	1.0			100 (4 days)
	0.5			99
	0.25			100
	0.125			89
	0.062			63
	0.031			54
	0.015			20
	0.007			3
	Check			1
AC-206-797 (American Cyanamid)	1.0			96
	0.5			92
	0.25			88
	0.125			79
	0.062			76
	Check			0
Bactospeine (Rhodia)	1.0			100
	0.5			95
	0.25			96
	0.125			73
	0.062			81
	Check			0

Material	Dosage lb/gal/A	Weather	Aging	Percent Mortality
Bromophos (Celamerck GmbH Co.)	1.0			100 (4 days
	0.5			100
	0.25			79
	0.125			12
	0.062			0
	Check			0
CGA-13353 (CIBA-Geigy)	1.0			15 (6 days)
	0.5			10
	0.25			2
	0.125			8
	0.062			5
	Check			0
CGA-18809 (CIBA-Geigy)	0.5			100 (3 days)
	0.25			100
Diazinon ULV (Trans Chemic)	3.8 lb/64 oz			100 (2 days)
	1.9 lb/32 oz			100
	0.9 lb/16 oz			100
	0.4 lb/8 oz			100
	0.2 lb/4 oz			97
	Check			0
	3.8 lb/64 oz			88 (3 days)
	1.9 lb/32 oz			44
	0.9 lb/16 oz			43
	0.4 lb/8 oz			7
	0.2 lb/4 oz			0
	Check			0
	3.8 lb/64 oz			65 (2 days)
	1.9 lb/32 oz			22
	0.9 lb/16 oz			9
	0.4 lb/8 oz			2
	0.2 lb/4 oz			2
	Check			0
Dimilin-25 W/P (Thompson-Hayward)	0.062			68 (6 days)
	0.015			59
	0.007			72
	Check			0
Dimilin 2 Flowable	0.062			78 (6 days)
	0.015			65
	0.007			69
	Check			0

Material	Dosage lb/gal/A	Weather	Aging	Percent Mortality	
Dimilin 25 W/P	0.062	Material mixed 38 days		73	(7 days)
	0.015	prior to treatment		90	
DS-244 65 (Diamond-Shamrock)	1.0	1"		66	(5 days)
	0.5	"		34	
	0.25	"		13	
	0.125	"		4	
	0.062	"		3	
	Check	"		0	
Dylox-Standard Formulation (Chemagro)	1.0			100	(6 days)
	1.0		8 days	100	
	0.5			100	
	0.5		8 days	100	
	0.125			100	
	0.125		8 days	100	
Dylox-New Molten Formulation	1.0			100	(6 days)
	1.0		8 days	100	
	0.5			100	
	0.5		8 days	100	
	0.125			100	
	0.125		8 days	34	(2 days)
	Check			0	
Dylox-Standard Formulation	1.0	1"		99	(6 days)
	0.5	"		97	
	0.25	"		59	
Dylox-New Molten Formulation	1.0	1"		100	(6 days)
	0.5	"		97	
	0.25	"		78	
	Check			0	
FMC-33297 (FMC-Niagara)	0.5			99	(3 days)
	0.25			97	
	0.125			100	
	0.062			99	
	0.031			93	
	0.015			69	
	0.007			38	
	0.003			35	
	0.001			17	
	Check			0	
	0.25		21 days	100	(5 days)
	0.125		21 days	96	

Material	Dosage lb/gal/A	Weather	Aging	Percent Mortality
FMC-33297 (FMC-Niagara)	0.25		52 days	99 (4 days)
	0.125		52 days	100
	1.0	1"		100 (3 days)
	0.5	"		99
	0.25	"		98
	0.125	"		81
	0.062	"		90
	0.031	"		86
	Check			0
	1.0			100 (3 days)
	0.5			100
	0.25			100
	0.125			97
	0.062			91
	0.031			65
	0.015			55
	0.007			39
	0.003			4
	Check			2
	1.0		8 days	100 (3 days)
	0.5			100
	0.25			98
	0.125			98
	0.062			80
	Check			0
	1.0	1"		100 (5 days)
	0.5	"		98
	0.25	"		98
	0.125	"		99
	0.062	"		98
	Check			0
	1.0	1"	7 days	72 (2 days)
	0.5	"		60
	0.25	"		39
	0.125	"		46
	0.062	"		25
	1.0	1"	15 days	99 (3 days)
	0.5	"		99
	0.25	"		98
	0.125	"		98
	0.062	"		80

Material	Dosage lb/gal/A	Weather	Aging	Percent Mortality	
Matacil (Chemagro)	1.0			100	(4 days)
	0.5			97	
	0.25			99	
	0.125			89	
	0.062			32	
	Check			0	
PP-557 (ICI)	0.5			100	(3 days)
	0.25			100	
	0.125			100	
	0.062			98	
	0.031			94	
	0.015			98	
	0.007			93	
	0.003			62	
	0.001			45	
	Check			0	
	0.031	1"		94	(3 days)
	0.015	"		95	
	0.007	"		74	
	0.003	"		55	
	0.001	"		17	
	Check			0	
SAN-197 (Sandoz Wander)	0.25	Material mixed 41 days		100	(4 days)
	0.06	before treatment		69	
Sumithion (Stauffer)	1.0			100	(5 days)
	0.5			100	
	0.25			99	
	0.125			99	
	0.062			88	
	0.031			28	
	Check			0	
S-15126 (Gulf)	0.5			100	(4 days)
	0.125			100	
	0.5	Material mixed 43 days		100	(5 days)
	0.125	before treatment		100	
	0.5	1"		100	(3 days)
	0.125	"		99	
	0.125	3"		97	
	0.125	4"		100	
	0.5	1"	14 days	100	(4 days)
	0.125	"	14 days	100	
	0.5	1"	23 days	100	
	0.125	"	23 days	88	
	Check			0	

Material	Dosage lb/gal/A	Weather	Aging	Percent Mortality
UC-51109 (Union Carbide)	1.0			100 (3 days)
	0.5			99
	0.25			99
	0.125			95
	0.062			91
	0.031			69
	0.015			17
	0.007			6
	0.003			2
	Check			0

The following materials gave no mortality after a 3 day exposure to 1.0 lb/gal/A.

A-13-18486
A-13-35522
A-13-35769
A-13-35700
A-13-35770
A-13-35771

SBP-1513, which is chemically the same as FMC-33297, was aged and exposed to UV light to compare its stability to that of Resmethrin.

Material	Dosage lb ai/gal/A	Hours UV Light	Percent Mortality
SBP-1513 (S.B. Penwick)	0.5	8	100 (3 days)
Resmethrin (S.B. Penwick)	0.5	8	100 "
SBP-1513	0.06	8	100 "
Resmethrin	0.06	8	24 "
SBP-1513	0.015	8	80 "
Resmethrin	0.015	8	21 "

Test data indicated that SBP 1513 is considerably more stable than Resmethrin when exposed to artificial ultraviolet radiation (290 to 320 nm) that induces pyrethroid destruction. This is especially true at the lower dosages that would be used with a pyrethroid treatment.

SBP 1513 also gave excellent mortality after various days of aging.

Material	Dosage lb/gal/A	Aging	Percent Mortality
SBP-1513			
(S.B. Penick)	0.5		100 (3 days)
	0.25		100
	0.25	8 days	100
	0.25	25 "	100
	0.25	37 "	99
	0.125		99
	0.125	8 days	95
	0.125	25 "	100
	0.125	37 "	100
	0.062		93
	0.062	8 days	84
	0.062	25 "	100
	0.062	35 "	95
	0.031		79
	0.031	8 days	58
	0.031	25 "	79
	0.031	37 "	84
	0.015		84
	0.007		75
	0.003		60
	0.001		40

Tests were conducted to compare Sevin-4-Oil to liquid Sevin.

Material	Dosage lb/gal/A	Weather	Aging	Percent Mortality
Sevin liquid	1.0			98 (4 days)
(Union Carbide)	"	1"		100 (3 days)
	"	3"		100 (5 days)
	"		9 days	100 (5 days)
	"		14 days	60 (2 days)
	0.5			94 (4 days)
	"	1"		92 (3 days)
	"	3"		98 (5 days)
	"		9 days	98 (5 days)
	"		14 days	36 (2 days)
	0.25			93 (4 days)
	"	1"		74 (3 days)
	"	3"		92 (5 days)
	"		9 days	100 (5 days)
	"		14 days	45 (2 days)

Material	Dosage lb/gal/A	Weather	Aging	Percent Mortality
Sevin-4-Oil (Union Carbide)	1.0			100 (3 days)
	"	1"		99 (3 days)
	"	3"		99 (5 days)
	"		9 days	100 (5 days)
	"		14 days	88 (2 days)
	0.5			100 (4 days)
	"	1"		90 (3 days)
	"	3"		100 (5 days)
	"		9 days	100 (5 days)
	"		14 days	85 (2 days)
	0.25			99 (4 days)
	"	1"		91 (3 days)
	"	3"		100 (5 days)
	"		9 days	98 (5 days)
	"		14 days	74 (2 days)

Laboratory Screening of Candidate Pesticides
Against the Gypsy Moth
September 1, 1975 - March 31, 1976

Project Number: GM 6.1.1
Project Title: Laboratory Screening of Candidate Pesticides Against the Gypsy Moth
Report Period: September 1, 1975 - March 31, 1976
Report Type: Interim
Project Leaders: Winfred H. McLane, Joyce A. Finney

The main objective of this laboratory screening project is to collect mortality data on experimental compounds potentially useful against the gypsy moth, evaluating the data and selecting suitable materials for field testing.

The following materials were tested against gypsy moth larvae using the oak seedling test technique.

Material	Company	Dosage	Instar	Weather	Aging	% Mortality	Days After Treatment
ABG-6070	Abbott	1.25 lb/gal/A	II			100	2
		0.62 lb/gal/A	"			99	3
		0.31 lb/gal/A	"			92	3
		0.15 lb/gal/A	"			81	3
		0.07 lb/gal/A	"			60	3
		0.03 lb/gal/A	"			62	3
		0.01 lb/gal/A	"			30	3
		0.009 lb/gal/A	"			11	3
		0.004 lb/gal/A	"			1	3
		Check	"			0	3
		.31 lb/gal/A	"	1"		45	5
		.15 lb/gal/A	"	1"		10	5
		.07 lb/gal/A	"	1"		13	5
		1.25 lb/gal/A	"		9	100	2
		0.62 lb/gal/A	"		9	60	2

Material	Company	Dosage	In-star	Weather	Days Aging	% Mor-tality	Days After Treat-ment
ABG-6070 (EC)	Abbott	0.31 lb/gal/A	II		9	58	2
		0.15 lb/gal/A	"		9	20	2
		0.07 lb/gal/A	"		9	20	2
		Check	"		9	0	2
Decis (EC)	Procida	0.13 lb/gal/A	"			98	4
		0.006 lb/gal/A	"			96	4
		0.003 lb/gal/A	"			90	4
		0.001 lb/gal/A	"			72	4
		0.0007 lb/gal/A	"			71	4
		Check	"			1	4
		0.003 lb/gal/A	"		31	13	2
		0.001 lb/gal/A	"		31	6	2
		Check	"		31	0	2
Dimilin (SULV)	Thompson-Hayward	0.208 lb/gal/A	"			95	6
		"	"	1"		86	6
		0.104 lb/gal/A	"			100	6
		"	"	1"		91	6
		0.052 lb/gal/A	"			90	6
		"	"	1"		91	6
		0.026 lb/gal/A	"			91	6
		"	"	1"		82	6

Material	Company	Dosage	In-star	Weather	Days Aging	% Mortality	Days After Treatment
Dimilin (SULV)	Thompson-Hayward	0.013 lb/gal/A	"			83	6
		"	"	1"		79	6
		Check	"			0	6
		0.06 lb/20 oz/A	"	1"		98	8
		"		2"		98	8
		"		3"		87	8
		0.03 lb/10 oz/A	"	1"		95	8
		"	"	2"		. 83	8
		"	"	3"		86	8
Dimilin (25 wp)	Thompson-Hayward	0.06 lb/gal/A	II	1" NO STICKER		98	10
		"	"	1" 3% CHEVRON STICKER ADDED		95	10
		"	"	2" NO STICKER		95	10
		"	"	2" 3% CHEVRON STICKER ADDED		85	10
		"	"	3" NO STICKER		90	8
		"	"	3" 3% CHEVRON STICKER ADDED		90	8
		"	"	4" NO STICKER		100	14
		"	"	4" 3% CHEVRON STICKER ADDED		100	14

Material	Company	Dosage	In-star	Weather	Days Aging	% Mortality	Days After Treatment
Dimilin (25 wp)	Thompson-Hayward	0.06 lb/gal/A	II	5" NO STICKER		98	14
		"	"	5" 3% CHEVRON STICKER ADDED		100	14
		0.03 lb/gal/A	II	1" NO STICKER		93	10
		"	"	1" 3% CHEVRON STICKER ADDED		99	10
		"	II	2" NO STICKER		82	10
		"	"	2" 3% CHEVRON STICKER ADDED		85	10
		"	II	3" NO STICKER		82	8
		"	"	3" 3% CHEVRON STICKER ADDED		86	8
		"	"	4" NO STICKER		100	14
		"	"	4" 3% CHEVRON STICKER ADDED		100	14
		"	"	5" NO STICKER		98	14
		"	"	5" 3% CHEVRON STICKER ADDED		98	14
		0.01 lb/gal/A	II	1" NO STICKER		99	10
		"	"	1" 3% CHEVRON STICKER ADDED		98	10

Material	Company	Dosage	In-star	Weather	Days Aging	% Mor-tality	Days After Treat-ment
Dimilin (25 wp)	Thompson-Hayward	0.01 lb/gal/A	II	2" NO STICKER		81	9
		"	"	2" 3% CHEVRON STICKER ADDED		96	9
		"	"	3" NO STICKER		84	8
		"	"	3" 3% CHEVRON STICKER ADDED		82	8
		"	"	4" NO STICKER		100	14
		"	"	4" 3% CHEVRON STICKER ADDED		100	14
		"	"	5" NO STICKER		97	14
		"	"	5" 3% CHEVRON STICKER ADDED		100	14
Orthene (2S)	Chevron	0.003 lb/gal/soln.	II	Soil around plants treated with 50 ml of lb/gal/soln. as indicated		100	4
		0.001 lb/gal/soln.	"	"		100	4
		0.00078 lb/ "	"	"		100	4
		0.00039 lb/ "	"	"		100	4
		Check	"			0	4
Orthene (75S)	Chevron	0.0156 lb/gal/A	II			99	6
		0.0078 lb/gal/A	II			96	6
		0.0039 lb/gal/A	II			18	6

Material	Company	Dosage	Instar	Weather	Days Aging	% Mortality	Days After Treatment
PP 557 (2 EC)	ICI	0.25 lb/gal/A	II	3"	43	99	8
		0.125 lb/gal/A	"	"	43	99	8
		0.06 lb/gal/A	"	"	43	98	8
		0.03 lb/gal/A	"	"	43	97	8
		Check	"	"	43	0	8
		0.06 lb/gal/A	"	NO SUNLIGHT		100	2
		"	"	EXPOSED TO 6 HRS NATURAL SUNLIGHT		99	2
		"	"	12.5 HRS ARTIFICIAL SUNLIGHT		100	7
		"	"	26 HRS ARTIFICIAL SUNLIGHT		100	4
		0.03 lb/gal/A	"	NO SUNLIGHT		98	2
		"	"	EXPOSED TO 6 HRS NATURAL SUNLIGHT		96	2
		"	"	12.5 HRS ARTIFICIAL SUNLIGHT		100	7
		"	"	26 HRS ARTIFICIAL SUNLIGHT		99	4
		0.01 lb/gal/A	"	NO SUNLIGHT		85	2
		"	"	6 HRS EXPOSURE TO NATURAL SUNLIGHT		98	2
		"	"	12.5 HRS OF ARTIFICIAL SUNLIGHT		100	7
		"	"	26 HRS ARTIFICIAL SUNLIGHT		100	4
RH-218 (EC)	ROHM and HAAS	1.25 lb/gal/A	"			100	2
		0.625 lb/gal/A	"			100	4

Material	Compnay	Dosage	In-star	Weather	Days Aging	% Mortality	Days After Treatment
RH-218 (EC)	Rohm and Haas	0.312 lb/gal/A	II			100	4
		0.156 lb/gal/A	"			100	4
		0.075 lb/gal/A	"			100	4
		0.037 lb/gal/A	"			97	3
		0.018 lb/gal/A	"			86	3
		0.009 lb/gal/A	"			96	6
		0.004 lb/gal/A	"			78	6
		Check	"			0	6
RH-0308 (EC)	"	1 lb/gal/A	"			92	2
		0.5 lb/gal/A	"			88	2
		0.25 lb/gal/A	"			64	2
		0.12 lb/gal/A	"			65	2
		0.06 lb/gal/A	"			39	2
		Check	"			1	2
SAN-197 (EC)	Sandoz-Wander	1.07 lb/gal/A	"			100	3
		0.53 lb/gal/A	"			98	3
		0.26 lb/gal/A	"			98	3
SAN-279 (EC)	Sandoz-Wander	1.07 lb/gal/A	"			100	3
		0.53 lb/gal/A	"			99	3
		0.26 lb/gal/A	"			96	3
		Check	"			0	3

Material	Company	Dosage	Instar	Weather	Days Aging	% Mortality	Days After Treatment
SD-41706 (EC)	Shell	1.2 lb/gal/A	II			100	2
		"	"		17	100	1
		0.6 lb/gal/A	"			100	3
		"	"		17	100	3
		0.3 lb/gal/A	"			100	3
		"	"		17	100	2
		0.1 lb/gal/A	"			99	3
		"	"		17	95	3
		0.07 lb/gal/A	"			95	3
		"	"		17	75	3
		Check	"			0	3
		0.07 lb/gal/A	"	1"		36	3
		"	"	1" 3% CHEVRON STICKER ADDED		60	3
		"	"	1" 3% CHEVRON STICKER ADDED		90	5
		0.037 lb/gal/A	"	1"		17	3
		"	"	1" 3% CHEVRON STICKER ADDED		46	3
		"	"	1" 3% CHEVRON STICKER ADDED		83	5
		0.018 lb/gal/A	"	1"		2	3
		"	"	1" 3% CHEVRON STICKER ADDED		18	3

Material	Company	Dosage	Instar	Weather	Days Aging	% Mortality	Days After Treatment
SD-41706 (EC)	Shell	0.018 lb/gal/A	II	1" 3% CHEVRON STICKER ADDED		28	5
		0.009 lb/gal/A	"	1"		0	3
		"	"	1" 3% CHEVRON STICKER ADDED		18	3
		"	"	1" 3% CHEVRON STICKER ADDED		28	5
		Check	"			0	5
Sumithion (40 wp)	Stauffer	1 lb/gal/A	"			100	3
		"	"	1"		24	5
		0.5 lb/gal/A	"			100	3
		"	"	1"		4	5
		0.25 lb/gal/A	"			77	3
		"	"	1"		1	5
		0.125 lb/gal/A	"			52	3
		"	"	1"		0	5
		0.06 lb/gal/A	"			28	3
		"	"	1"		0	5
Sumithion (8 EC)	"	1 lb/gal/A	"			100	3
		"	"	1"		15	5
		"	"	1" 3% CHEVRON STICKER ADDED		60	7

Material	Company	Dosage	In-star	Weather	Days Aging	% Mor-tality	Days After Treat ment
Sumithion (8 EC)	Stauffer	1 lb/gal/A	II	2" 3% CHEVRON STICKER ADDED		33	6
		"	"	1" 6% CHEVRON STICKER ADDED		28	5
		"	"			100	3
		"	"	1" 3% PINOLENE STICKER ADDED		7	3
		"	"	1" 6% PINOLENE STICKER ADDED		48	3
		"	"	1" 3% RHOPLEX STICKER ADDED		100	3
		"	"	1" 6% RHOPLEX STICKER ADDED		98	3
		0.5 lb/gal/A	"			100	3
		"	"	1"		1	5
		"	"	1" 3% CHEVRON STICKER ADDED		17	7
		"	"	2" 3% CHEVRON STICKER ADDED		17	5
		"	"	1" 6% CHEVRON STICKER ADDED		19	5
		0.25 lb/gal/A	"			100	7
		"	"	1"		0	3
		"	"	1" 3% CHEVRON STICKER ADDED		61	7

Material	Company	Dosage	In-star	Weather	Days Aging	% Mortality	Days After Treatment
Sumithion	Stauffer	0.25 lb/gal/A	II	2" 3% CHEVRON STICKER ADDED		29	6
		"	"	1" 6% CHEVRON STICKER ADDED		38	5
		0.12 lb/gal/A	II			97	7
		"	"	1"		0	5
		"	"	1" 3% CHEVRON STICKER ADDED		49	7
		"	"	2" 3% CHEVRON STICKER ADDED		11	6
		"	"	1" 6% CHEVRON STICKER ADDED		11	5
		0.06 lb/gal/A	"			96	7
		"	"	1"		0	5
		"	"	1" 3% CHEVRON STICKER ADDED		27	7
		"	"	2" 3% CHEVRON STICKER ADDED		26	6
		"	"	1" 6% CHEVRON STICKER ADDED		28	5
		0.03 lb/gal/A	"			29	6
		0.01 lb/gal/A	"			9	6
		Check	"			0	7

Material	Company	Dosage	In-star	Weather	Days Aging	% Mor-tality	Days After Treat-ment
Sumithion (8 EC)	Stauffer	1 lb/gal/Soln.	II	LARVAE SPRAYED DIRECTLY THEN EXPOSED TO ARTI-FICIAL DIET		96	1
TH-6042 (2 FL)	Thompson-Hayward	0.06 lb/gal/A	"			100	16
		0.03 lb/gal/A	"			100	16
		0.015 lb/gal/A	"			100	16
		0.007 lb/gal/A	"			100	16
		0.003 lb/gal/A	"			100	16
		Check	"			0	16
WL-43775	Shell	1.2 lb/gal/A	"			100	3
		"	"		17	100	2
		0.6 lb/gal/A	"			100	3
		"	"		17	100	2
		0.3 lb/gal/A	"			100	3
		"	"		17	100	3
		0.1 lb/gal/A	"			100	3
		"	"		17	99	3
		0.07 lb/gal/A	"			100	3
		"	"		17	97	3
		Check	"			0	3
		0.07 lb/gal/A	"	1"		92	6
		"	"	1" 3% CHEVRON STICKER ADDED		100	3

Material	Company	Dosage	Instar	Weather	Days Aging	% Mortality	Days After Treatment
WL-43775	Shell	0.03 lb/gal/A	II	1"		57	6
		"	"	1" 3% CHEVRON STICKER ADDED		96	4
		0.01 lb/gal/A	"	1"		38	6
		"	"	1" 3% CHEVRON STICKER ADDED		80	4
		0.009 lb/gal/A	"	1"		22	6
		"	"	1" 3% CHEVRON STICKER ADDED		58	4

A test was conducted with the growth regulator RO-10-3108 from HLR Sciences:

<u>Test Insects Used</u>: Laboratory reared 4th instar gypsy moth larvae. Larvae were reared on artificial diet up until time of test. One hundred larvae were exposed to RO-10-3108 treatment and 100 were used as a control.

<u>Treatment Used</u>: Northern red oak seedlings were sprayed in a laboratory spray chamber. Ten plants were treated and then 10 larvae were introduced onto the treated foliage of each plant. Ten untreated plants acted as controls.

<u>Dosage and Rate Applied</u>: Test material was applied to the foliage at 0.5 lb ai/gal/A.

<u>Formulation Used</u>: RO-10-3108, 50% EC - (ACR 2019E). Sample was received by Otis September 26, 1975.

<u>Holding Chamber</u>: After treatment and larval introduction, plants were held at 26.67°C with a relative humidity of 60%.

<u>Results</u>: As 4th instar gypsy moth larvae consume large amounts of foliage daily, it was necessary to feed larvae daily. New foliage, when introduced to the treatment, was newly sprayed with RO-10-3108 at 0.5 lb ai/gal/A. New control plants were not treated. At the time of feeding,

mortality readings were made and general observations were made and recorded.

After a 2 week exposure to treated foliage, a substantial decrease in feeding occurred and larvae started to look sick. At the same time, control larvae continued to feed well. From this point until the test was terminated, treatment plants were changed about every 2-3 days. Controls continued to be changed daily. Treatment insects had new sprayed foliage a total of 25 times with controls having new foliage a total of 43 times.

Throughout the test, larval mortality occurred in both treated and controls. This was due to virus, cannibalism and effects of RO-10-3108. The end result was the development of 14 healthy pupae in the controls and no pupal development from the 100 larvae exposed to RO-10-3108 at 0.5 lb ai/gal/A. This would indicate that, in the laboratory, pupal development can be impeded, resulting in excellent control of the gypsy moth. However, large amounts of treated foliage had to be consumed to achieve this. It is questionable if this amount would be available under field conditions. Work should now continue to determine the precise dosage and exposure needed to achieve adequate control. When this is obtained, we will then be able to tell where the material might fit into the overall gypsy moth program.

Material	Dosage	No. Test Insects	Instar	% Pupae Recovered
RO-10-3108	0.5 lb ai/gal/A	100	4th	0
Control	"	100	4th	14

During this reporting period much time has been spent working with a new Sevin-4-Oil formulation. Mr. J. Henderson, pilot, Beltsville, MD, found that with the assistance of select emulsifiers, he was able to dilute Sevin-4-oil with water. We have worked with Mr. Henderson on this and have developed a formulation that will be tested in the field during 1976. If workable in the field, the formulation could save substantial amounts of money in the gypsy moth program. It might also be adapted to a number of other programs.

A total of 16 emulsifiers were tested:

Sponto AK16-95	Target E	Triton X-180	Triton CS-7
Sponto H44C	Folicole	Triton X-190	Triton 1956
Sponto 6525	Adser 775	Triton X-301	Foamwet
Sponto 207	Triton X-100	Triton X-305	Top Job

Of this group, Triton X-190, Sponto AK16-95 and Sponto H44C appeared to be the most promising. A material labelled Triton X-300 was also tested. However, when Rohm and Haas were asked about the material, they said they had no record showing they ever produced the material.

The Sevin-4-Oil was cut to 2 lb ai/gal/sol. by using 2 percent of emulsifier and 50 percent water. The following tests were then conducted.

Material: Sevin-4-Oil

Emulsifier	Dosage	Weather	Instar	% Mortality	Days After Treatment
Kerosene	1 lb/40 oz/A		II	100	3
Triton X-300	1 lb/.5 gal/A		"	100	3
Sponto H44C	1 lb/.5 gal/A		"	100	3
Triton X-190	1 lb/.5 gal/A		"	97	4
Kerosene	1 lb/40 oz/A	Aged 17 Days	"	93	2
Triton X-300	1 lb/.5 gal/A	"	"	80	2
AK16-95	1 lb/.5 gal/A		"	100	3
Kerosene	1 lb/40 oz/A	Material Heated to 80°C	"	100	3
"	"	Material Cooled to 0°C	"	98	3
Triton X-190	0.5 lb/qt/A	Material Heated to 80°C	"	100	3
"	"	Material Cooled to 0°C	"	99	3
Sponto H44C	"	Material Heated to 80°C	"	100	3
"	"	Material Cooled to 0°C	"	99	3

Material: Sevin-4-Oil

Emulsifier	Dosage	Weather	Instar	% Mortality	Days After Treatment
Sponto H44C	0.5 lb/qt/A		II	99	4
	0.25 lb/pt/A		"	90	4
Triton X-190	0.5 lb/qt/A		"	100	3
	0.25 lb/pt/A		"	93	4
	Check		"	0	4
Kerosene	0.5 lb/20 oz/A		"	100	3
	0.25 lb/pt/A		"	98	4
Triton X-300	0.5 lb/qt/A		"	100	3
	0.25 lb/pt/A		"	99	4
Kerosene	1 lb/40 oz/A	Aged 17 days	"	93	2
	0.5 lb/20 oz/A	"	"	88	2
Triton X-300	1 lb/.5 gal/A	"	"	88	2
	0.5 lb/qt/A	"	"	83	2
AK16-95	1 lb/.5 gal/A	"	"	100	3
	"	1"	"	100	3
	"	2"	"	100	3
	0.5 lb/qt/A		"	100	3
	"	1"	"	100	3
	"	2"	"	98	3
Kerosene	1 lb/40 oz/A	1"	"	99	3

Material: Sevin-4-Oil

Emulsifier	Dosage	Weather	Instar	% Mortality	Days After Treatment
Kerosene	0.5 lb/20 oz/A	1"	II	99	3
	0.25 lb/10 oz/A	1"	"	89	3
Triton X-300	1 lb/.5 gal/A	1"	"	99	3
	0.5 lb/qt/A	1"	"	96	3
	0.25 lb/pt/A	1"	"	90	3
Sponto H44C	1 lb/.5 gal/A	1"	"	98	3
	0.5 lb/qt/A	1"	"	99	3
	0.25 lb/pt/A	1"	"	90	3
Triton X-190	1 lb/.5 gal/A	1"	"	97	3
	0.5 lb/qt/A	1"	"	95	3
	0.25 lb/pt/A	1"	"	79	3
Kerosene	1 lb/40 oz/A	1" Heated to 80°C	"	99	3
	"	1" Cooled to 0°C	"	98	3
Triton X-190	0.5 lb/qt/A	1" Heated to 80°C	"	99	3
	"	1" Cooled to 0°C	"	93	3
Sponto H44C	"	1" Heated to 80°C	"	100	3
	"	1" Cooled to 0°C	"	100	3
Kerosene	1 lb/40 oz/A	2"	"	99	3
	0.5 lb/20 oz/A	2"	"	96	3
	0.25 lb/10 oz/A	2"	"	99	3

Material: Sevin-4-Oil

Emulsifier	Dosage	Weather	Instar	% Mortality	Days After Treatment
Triton X-300	1 lb/.5 gal/A	2"	II	100	3
	0.5 lb/qt/A	2"	"	99	3
	0.25 lb/pt/A	2"	"	89	3
Triton X-190	1 lb/.5 gal/A	2"	"	98	4
	0.5 lb/qt/A	2"	"	99	4
	0.25 lb/pt/A	2"	"	77	4
Sponto H44C	1 lb/.5 gal/A	2"	"	99	4
	0.5 lb/qt/A	2"	"	99	4
	0.25 lb/pt/A	2"	"	95	4
Kerosene	1 lb/40 oz/A	2" Heated to 80°C	"	100	3
	"	2" Cooled to 0°C	"	96	3
Triton X-190	0.5 lb/qt/A	2" Heated to 80°C	"	95	3
	"	2" Cooled to 0°C	"	98	3
Sponto H44C	0.5 lb/qt/A	2" Heated to 80°C	"	97	3
	"	2" Cooled to 0°C	"	89	3
Triton X-190	0.5 lb/gal/A		"	97	3
	0.25 lb/.5gal/A		"	93	3
	0.12 lb/qt/A		"	95	3
	0.5 lb/gal/A	1"	"	90	3
	0.25 lb/.5 gal/A	1"	"	58	3
	0.12 lb/qt/A	1"	"	12	3

Approximately 145 gallons of northern red oak acorns were collected and stored in cold storage. Five gallons were sent to Dr. Forgash of Rutgers for use in insecticide and parasite work. Northern New England personnel also collected acorns for the Otis laboratory.

Very limited work was started with spray droplet size in the laboratory. It consisted mainly of reviewing literature.

A small group of Apanteles melanocelus and Exorista larvarum were received at the screening laboratory.

A total of 35 insecticide samples and 5 emulsifiers were received for laboratory tests.

The insecticide spray chamber was calibrated using gas chromatography.

Sample No.	Treatment (Malathion) lb/A	Analytical Results lb/A	Average	Range
B-0.068-I	0.068	0.072	0.076	0.067-0.083
II	"	0.067		
III	"	0.083		
IV	"	0.081		
V	"	0.076		
B-0.13-I	0.13	0.091	0.088	0.072-0.101
II	"	0.093		
III	"	0.081		
IV	"	0.101		
V	"	0.072		
B-0.27-I	0.027	0.024	0.021	0.196-0.24
II	"	0.204		
III	"	0.204		
IV	"	0.196		
V	"	0.196		
B-0.55-I	0.55	0.412	0.435	0.412-0.47
II	"	0.412		
III	"	0.44		
IV	"	0.44		
V	"	0.47		
B-1.1-I	1.1	0.85	0.89	0.821-0.98
II	"	0.821		
III	"	0.936		
IV	"	0.879		
V	"	0.98		

Sample No.	Treatment (Malathion) lb/A	Analytical Results lb/A	Average	Range
C-0.06-I	0.06	0.056	0.056	0.051-0.060
II	"	0.054		
III	"	0.051		
IV	"	0.057		
V	"	0.060		
C-0.13-I	0.13	0.101	0.101	0.091-0.11
II	"	0.091		
III	"	0.101		
IV	"	0.102		
V	"	0.11		
C-0.27-I	0.27	0.34	0.37	0.34-0.41
II	"	0.034		
III	"	0.041		
IV	"	0.041		
V	"	0.036		
C-0.55-I	0.55	0.55	0.55	0.52-0.58
II	"	0.58		
III	"	0.54		
IV	"	0.52		
V	"	0.55		
C-1.1-I	1.1	1.37	1.44	1.31-1.53
II	"	1.49		
III	"	1.53		
IV	"	1.49		
V	"	1.31		

Mr. McLane worked with District Director Mr. V. A. LaFleur in revising the APHIS regulatory manual.

Speeches

Mr. McLane gave a 1 hour talk on new developments in gypsy moth control to the Barnstable, Mass. Grubbers Club. A question and answer period followed the presentation.

Meetings

Mr. White, Mr. Holland and Mr. Reardon met at Otis with Mr. Herbaugh and

Mr. McLane to discuss 1976 insecticide laboratory and field work.

A regulatory meeting was held at Otis to discuss regulatory problems, mainly recreational vehicles and house trailers.

The Massachusetts Horticultural Congress, Boston, Mass.

Northeast Aerial Applicators Conference, Ithaca, NY.

Visitors

Mr. O. C. Zoebisch, DuPont
Mr. R. H. Sparnicht, Thompson-Hayward
Mr. R. P. Stollings, Thompson-Hayward
Mr. C. Byrd, Sandoz-Wander
Mr. R. Perry, FMC
Mr. R. Kelliher, Mass. Dept. of Natural Resources
Mr. Lister, Univ. of Massachusetts
Mr. R. D. Cannizzaro, Thompson-Hayward

APPENDIX I Field Evaluations of Insecticides Against the Gypsy Moth *Porthetria dispar* (L.)

APPENDIX I

Field Evaluations of Insecticides Against the Gypsy Moth *Porthetria dispar* (L.)

by

Larry L. Herbaugh, W. H. McLane and C. R. Stacy

Introduction

The gypsy moth, Porthetria dispar (L.) continues to be one of the major destructive pests of deciduous forests. In recent years thousands of acres of hardwood forests have been defoliated in 9 northeastern states. In 1973 alone, caterpillars defoliated about 1,744,000 acres of woodland (Mulhern 1973). Scientists have yet to develop control methods that can contain this unique insect to a limited area. Survey traps capture adult males in virtually all parts of the country.

The gypsy moth has only one generation per year with larvae hatching from overwintering eggs in the spring at the time oak foliage begins to unfold. These larvae feed and cause defoliation until the first part of July and then go into pupation for approximately 2 weeks, emerge as adults, mate and deposit egg masses, each containing several hundred eggs, completing the cycle (Forbush and Fernald 1896).

Many different types of control techniques have been attempted since the insect was accidentally released in Massachusetts in 1869. Most successful of these techniques is the use of pesticides. However, with the restricted use of chemicals, primarily

DDT, that were previously used for control, a continuing search is being made for an effective pesticide. Because of our concern with environmental pollution, it becomes increasingly important that we screen materials before using them in the field. This type of screening process is carried out with materials at the USDA, Gypsy Moth Methods Development Laboratory, Otis Air Force Base, Massachusetts (McLane 1973). After extensive laboratory screening, only those materials that show a minimal environmental hazard and good potential for field control are then tested under field conditions. Field trials reported here were conducted in the 1974 season from materials previously used and/or tested in the laboratory at Otis AFB (McLane 1974).

Materials and Methods

All of the materials used in the 1974 field trials were selected on the basis of their performance in laboratory conditions against artificial diet reared gypsy moth larvae(McLane 1973). Some of the materials had been previously field tested with inconclusive results that needed further decisive tests.

Bioethanomethrin, a synthetic pyrethroid, is a safe material

from the standpoint of toxicity. Laboratory tests showed it to be very effective as a control poison against gypsy moth larvae (McLane 1973). This material had been tested in field plots in 1973 in Pennsylvania but a general population collapse occurred and it was felt that for a true effectiveness evaluation of this material it should be retested. This material was tested at 0.02 lbs ai/gal/A and at 0.05 lbs ai/gal/A with a 15% CIB molasses concentrate (see Table 1).

CGA-18809, an organophosphate, shows an acute oral LD 50 of 1180 mg/kg (rat) and no phytotoxicity under limited field evaluations (CIBA-GEIGY). Laboratory tests showed it gave excellent results both as a contact and a stomach poison against lab-reared gypsy moth larvae (McLane, unpublished). This material was applied at 1.0 lbs ai/qt/A with a 3% Chevron sticker (see Table 1).

In laboratory tests, experimental formulations of encapsulated Diazinon and Sumithion performed sufficiently long after technical formulation tests had concluded for lack of activity. This work was conducted in cooperation with Pennwalt Corp. for formulation of the experimental encapsulated materials. Materials were applied at 0.5 lbs ai/gal/A and 1.0 lbs ai/gal/A respectively.

Imidan is an organophosphate insecticide that exerts its toxic action by inhibiting cholinesterace in insects and other living organisms which have a cholinergic system (Stauffer Chemical Co. November 1969). This was tested in 1973 but because of a general natural collapse in the area it was decided to retest it in 1974 at 0.5 lbs ai/gal/A (see Table 1).

Orthene, commonly called acephate, is an organic phosphate insecticide of moderate persistence with a relatively short 5-10 day residual activity. This material has an acute oral toxicity in purebred beagle dogs of 681 mg/kg minimum lethal dose. The acute oral LD 50 of technical Orthene for chickens is 852 mg/kg and 350 mg/kg for mallard ducks (Chevron Chemical Co. 1972). This material was tested as orthene + H_2O at 0.5 lbs ai/2 qt/A and orthene + propolene glycol at the same rate (see Table 1).

TH 6040 is an insect growth regulator which showed excellent promise under laboratory conditions. The mode of action is to inhibit chitin formation of larvae upon molting. This shows no phytoxicity at 10,000 ppm spray concentration and has an oral LD 50 on male mice of 3160 mg/kg (14 day) and an LC 50 to guppy

of 100 ppm (5 day exposure), (Thompson-Hayward Chemical Co.). This material was applied at 0.06 lbs ai/gal/A and 0.3 lbs ai/gal/A with 3% Chevron sticker (see Table 1).

Table 1. Details of 1974 formulations field-tested.

Material	Application rate/acre	Chemical Concentration	Sticker
Bioethanomethrin			
a	1 gal/acre	0.02# ai/gal	CIB at 15% concentration
b	1 gal/acre	0.05# ai/gal	"
CGA-18809	1 gal/acre	0.5# ai/gal	Chevron at 3% concentration
Encap Diazinon	1 gal/acre	0.5# ai/gal	None
Encap Sumithion	1 gal/acre	1.# ai/gal	None
Imidan	1 gal/acre	0.5# ai/gal	None
Orthene + Propolene Glycol	2 qt/acre	.5# ai/2 qt	None
Orthene + H 0	2 qt/acre	.5# ai/2 qt	None
TH 6040			
a	1 gal/acre	0.06# ai/gal	Chevron at 3% concentration
b	1 gal/acre	0.3# ai/gal	"

Plot Establishment: An area in Hamden county, Mass. was selected in 1974 as meeting the criteria for establishing experimental plots. The criteria are the following. (1) an area in which the population is building and in which there had been no more than 1 year's noticeable defoliation prior to the test year; (2) a readily measureable population within the range of 100 to 900 egg masses per acre; (3)predominance of preferred host trees (oaks).

Each plot was laid out by establishing an accessible base corner and running boundary lines along compass headings resulting in a square with sides of 1476 ft and a 50 acre plot. A marker was placed at all four corners for aircraft guidance. These markers consisted of white canvas bags slipped over folded branches on the ends of saplings. The saplings, in turn, were raised through the canopy and fastened so that the bags were 10 to 15 ft above tree top level.

Within each 50 acre plot, 5 subplots or sampling units were established. Each encompassed 66 sq ft or 0.1 acre and were randomly placed throughout the plot. These subplots were chosen to represent the entire plot and served as sampling points throughout the experiment. A series of these sampling points were established in untreated check areas to measure natural conditions.

For guidance and convenience to the ground crews a tag was placed on the base corner tree and identified its location, e.g., NW corner of plot 3. The perimeter boundaries were marked in orange ribbon, the lines to the subplots in blue ribbon and the subplots in white ribbon with a tag on a corner identifying it.

Application: The application schedule was designed so that material was to be applied when the majority of larvae were in the late 2nd instar stage and the oak foliage was 50-75 percent expanded. However, due to circumstances beyond our control only plots 22 and 23 and part of 20 had material applied on this schedule. The remaining plots were delayed a week before application resumed. During this time rain and warm weather caused rapid leaf expansion and insect growth. As a result, most target insects were in the 3rd instar and leaf expansion on preferred host plants was nearly 100 percent.

All plots were treated with a Piper Pawnee aircraft equipped with a propeller-driven impeller pump and a conventional spray system. The airplane dispersed the material in 75 foot swaths at 100 mph as near to tree top level as possible with a ground wind velocity of less than 5 mph.

Materials were mixed and put into aircraft with conventional mixing equipment consisting of 2 mixing tanks, pumps, hoses, measuring devices, and necessary safety equipment. All mixing and spraying equipment was thoroughly cleaned between each treatment to avoid adulteration.

The following table shows the different arrangements used on the conventional spray system.

Material	Orifice	Screen Mesh	psi	Degree to Slipstream
Bioethanomethrin	18-8008 flat fan	25-mesh	40	90°
CGA-18809	18-8008 flat fan	25-mesh	40	90°
Encap Diazinon	18-8008 flat fan	no screen	42	90°
Encap Sumithion	18-8008 flat fan	no screen	42	90°
Imidan	18-8008 flat fan	25-mesh	40	90°
Orthene + Propolene glycol	18-8002 flat fan	25-mesh	40	straight aft
Orthene + H_2O	18-8004 flat fan	25-mesh	40	straight aft
TH-6040	18-8008 flat fan	25-mesh	40	90°

During spray operations, radio communications were maintained between the ground crew and the observation plane in respect to ground conditions such as wind velocity and material dispersement. The observation plane was used to guide the pilot to the plot, indicate the boundaries and general observation of the work.

Evaluation: Each treatment was evaluated from the standpoint of foliage protection and population reduction.

The degree of foliage protection was estimated by visual examination of the degree of defoliation in each of the sampling plots at the termination of larval feeding. These estimates were made in 20% increments and were all made by the same crew so that human judgement would remain constant (see Table 3).

Population reduction was estimated by using a system similar to that described by Campbell (1967) in which the beginning larval population is estimated from egg mass density and viability data.

In early spring, the egg masses were counted in each subplot to

determine number of egg masses/acre before treatment. Egg masses were collected adjacent to the sampling plots and were stratified to represent above and below the snowline. These collections were incubated in the laboratory to provide the following data: Number of eggs/mass, number of larvae successfully hatched, and the percent hatch for each egg mass. An estimate of beginning larval population was computed by: (number egg mass/acre) (number eggs/mass) (% hatch) = number of beginning larvae per acre (see Table 4).

The percent reduction in egg mass population was calculated by counting the egg masses in each subplot after leaf drop and using the following formula $\frac{\text{fall egg mass/acre}}{\text{spring egg mass/acre}} \times 100 = \%$ reduction in egg masses (see Table 4).

To determine residual effects on larval mortality a 3' X 3' white drop cloth was placed under a representative preferred host tree in each of the sampling units. Daily readings were made and recorded on each of these until mortality ceased to be significant. With the exception of TH 6040 this was 96 hours or less (see Table 5).

Table 3.

Material		Plot	% Defoliation
Imidan	.5 lb/gal/ac	1	4-23
Imidan	.5 lb/gal/ac	4	44-63
Imidan	.5 lb/gal/ac	24	60-80
Orthene + H_2O	.5 lb/2 qt/ac	20	0-19
Orthene + H_2O	.5 lb/2 qt/ac	23	16-35
Orthene + Propolene Glycol	.5 lb/2 qt/ac	22	28-43
Orthene + Propolene Glycol	.5 lb/2 qt/ac	18	8-27
Orthene + Propolene Glycol	.5 lb/2 qt/ac	12	12-31
Bioethanomethrin	.05 lb/gal/ac	10	20-39
Bioethanomethrin	.05 lb/gal/ac	16	56-75
Bioethanomethrin	.05 lb/gal/ac	13	40-59
Bioethanomethrin	.02 lb/gal/ac	2	40-59
Bioethanomethrin	.02 lb/gal/ac	9	32-51
Bioethanomethrin	.02 lb/gal/ac	11	28-47
TH-6040	.06 lb/gal/ac	3	0-19
TH-6040	.06 lb/gal/ac	5	4-23
TH-6040	.06 lb/gal/ac	8	0-19
TH-6040	.3 lb/gal/ac	6	12-23
TH-6040	.3 lb/gal/ac	19	0-19
TH-6040	.3 lb/gal/ac	21	32-51
Encap Diazinon	.5 lb/gal/ac	14	48-67
Encap Sumithion	1 lb/gal/ac	17	44-63
CGA-18809	.5 lb/gal/ac	15	0-19
Control		1	40-59
"		2	80-100
"		3	80-100
"		4	20-39
"		5	48-67
"		6	68-83
"		7	80-100
"		8	76-96

TABLE 4.

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease / increase
Bioethanomethrin .02 lb/gal/ac	2	1	1,400	308	85	366,800	30	- 98%
		2	1,400	308	85	366,800	240	- 83
		3	1,400	308	85	366,800	70	- 95
		4	1,400	308	85	366,800	90	- 94
		5	1,400	308	85	366,800	0	-100
Average			1,400 1/	308	85	366,800	86	- 94%
	9	1	450	308	85	117,900	30	- 93%
		2	450	308	85	117,900	60	- 87
		3	450	308	85	117,900	20	- 96
		4	450	308	85	117,900	240	- 47
		5	450	308	85	117,900	300	- 33
Average			450 1/	308	85	117,900	130	- 71%
	11	1	130	329	87	37,209	60	- 54%
		2	1,520	528	88	706,252	1,380	- 9
		3	220	408	95	84,436	330	+ 50
		4	2,070	393	89	724,023	730	- 65
		5	3,090	283	77	673,341	1,370	- 56
Average			1,406	388	87	445,052	774	- 45%
Treatment Averages			1,085	335	86	309,917	330	- 70%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease ∕ increase
Bioethanomethrin .05 lb/gal/ac	10	1	650	308	85	34,060	200	- 69%
		2	650	308	85	34,060	100	- 85
		3	650	308	85	34,060	120	- 82
		4	650	308	85	34,060	1,320	+103
		5	650	308	85	34,060	310	- 52
Average			650 1/	308	85	34,060	410	- 37%
	13	1	1,010	329	87	37,209	90	- 91%
		2	1,880	528	88	706,252	250	- 87
		3	1,050	408	95	84,436	200	- 81
		4	1,990	393	89	724,023	50	- 97
		5	2,130	283	77	673,341	40	- 98
Average			1,612	388	87	445,052	126	- 92%
	16	1	1,090	219	92	215,613	240	- 78%
		2	1,540	232	92	328,697	450	- 71
		3	2,850	180	85	436,050	480	- 83
		4	1,640	243	81	322,801	580	- 65
		5	570	218	82	101,893	660	+ 15
Average			1,538	218	86	281,011	482	- 69%
Treatment Averages			1,267	305	86	253,374	339	- 73%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease ∕ increase
CGA-18809	15	1	420	386	88	142,665	0	-100%
0.5 lbs/gal/A		2	100	388	71	35,388	0	-100
		3	150	410	73	44,895	0	-100
		4	260	428	90	100,152	10	- 96
		5	210	414	89	77,376	0	-100
Average			456	405	82	80,095	2	- 99%
Treatment Averages			456	405	82	80,095	2	- 99%
Encapsulated	14	1	670	334	77	172,310	190	- 72%
Diazinon		2	1,580	218	86	296,218	120	- 92
0.5 lbs/gal/A		3	2,900	218	80	505,760	120	- 96
		4	5,550	317	86	1,513,041	110	- 98
		5	3,440	250	81	696,600	300	- 91
Average			2,828	267	82	636,785	168	- 94%
Treatment Averages			2,828	267	82	636,785	168	- 94%
Encapsulated	17	1	290	249	83	59,934	70	- 76%
Sumithion		2	2,360	289	85	579,734	650	- 72
1.0 lbs/gal/A		3	1,520	316	89	425,484	350	- 77
		4	1,060	385	86	350,966	240	- 77
		5	390	355	79	107,375	150	- 62
Average			1,124	319	84	304,699	292	- 74%
Treatment Average			1,124	319	84	304,699	292	- 74%

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease ∓ increase
Imidan	1	1	300	308	85	78,600	540	+ 80%
0.5 lbs/gal/A		2	300	308	85	78,600	720	+140
		3	300	308	85	78,600	300	0
		4	300	308	85	78,600	270	- 10
		5	300	308	85	78,600	470	+ 57
Average			300 1/	308	85	78,600	460	+ 87%
	4	1	1,400	308	85	366,800	310	- 78%
		2	1,400	308	85	366,800	450	- 68
		3	1,400	308	85	366,800	420	- 70
		4	1,400	308	85	366,800	160	- 89
		5	1,400	308	85	366,800	240	- 83
Average			1,400 1/	308	85	366,800	596	- 57%
	24	1	570	387	90	198,531	930	+ 63%
		2	450	343	87	134,284	410	- 8
		3	1,650	351	89	515,443	890	- 46
		4	500	282	82	115,620	1,430	+186
		5	310	266	82	67,617	120	- 61
Average			696	326	86	206,299	756	+ 8%
Treatment Average			799	314	85	217,233	604	- 24%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease ≠ increase
Orthene+H20 0.5 lbs/2 qt/A	20	1	820	408	80	267,648	10	- 99%
		2	1,660	309	94	492,163	70	- 96
		3	1,930	295	92	523,802	280	- 85
		4	1,150	338	89	345,943	missed by spray	
		5	1,590	232	77	284,037	missed by spray	
Average			1,470	337	89	427,871	120	- 92%
	23	1	1,070	438	88	412,420	740	- 31%
		2	250	636	95	155,800	140	- 44
		3	640	384	91	223,641	270	- 58
		4	870	297	90	238,032	380	- 56
		5	750	304	90	205,200	160	- 79
Average			716	416	91	247,019	338	- 53%
Treatment Average			1,093	377	90	337,445	229	- 79%
Orthene + Propolene Glycol 0.5 lbs/2 qt/A	12	1	660	228	92	138,441	660	0%
		2	230	330	88	66,792	250	+ 9
		3	80	329	95	25,004	0	-100
		4	430	335	87	125,323	40	- 91
		5	460	341	90	147,174	650	+ 41
Average			372	313	90	100,547	320	- 14%
	18	1	1,100	308	85	288,200	0	-100%
		2	1,100	308	85	288,200	0	-100
		3	1,100	308	85	288,200	90	- 92
		4	1,100	308	85	288,200	30	- 97
		5	1,100	308	85	288,200	10	- 99
Average			1,100 1/	308	85	288,200	26	- 98%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease / increase
Orthene + Propolene	22	1	850	403	91	311,720	1,240	+ 46%
Glycol		2	370	443	94	141,451	240	- 35
0.5 lbs/gal/A		3	660	364	94	225,825	670	+ 2
		4	590	332	92	180,209	470	- 20
		5	1,010	353	96	342,268	820	- 19
Average			696	379	93	240,294	688	- 1%
Treatment Average			723	540	89	209,680	345	- 52%
TH-6040	3	1	1,200	308	85	314,400	0	-100%
.06 lb/gal/ac		2	1,200	308	85	314,400	0	-100
		3	1,200	308	85	314,400	0	-100
		4	1,200	308	85	314,400	0	-100
		5	1,200	308	85	314,400	0	-100
Average			1,200 1/	308	85	314,400	0	-100%
	5	1	1,500	308	85	393,000	0	-100%
		2	1,500	308	85	393,000	0	-100
		3	1,500	308	85	393,000	0	-100
		4	1,500	308	85	393,000	0	-100
		5	1,500	308	85	393,000	0	-100
Average			1,500 1/	308	85	393,000	0	-100%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease / increase
TH-6040 .06 lb/gal/ac	8	1	1,200	308	85	314,400	0	-100%
		2	1,200	308	85	314,400	0	-100
		3	1,200	308	85	314,400	0	-100
		4	1,200	308	85	314,400	0	-100
		5	1,200	308	85	314,400	0	-100
Average			1,200 1/	308	85	314,400	0	-100%
Treatment Average			1,300	308	85	340,600	0	-100%
TH-6040 .3 lb/gal/ac	6	1	1,400	308	85	366,800	0	-100%
		2	1,400	308	85	366,800	0	-100
		3	1,400	308	85	366,800	0	-100
		4	1,400	308	85	366,800	0	-100
		5	1,400	308	85	366,800	0	-100
Average			1,400 1/	308 1/	85 1/	366,800	0	-100%
	19	1	1,100	308	85	288,200	0	-100%
		2	1,100	308	85	288,200	0	-100
		3	1,100	308	85	288,200	0	-100
		4	1,100	308	85	288,200	0	-100
		5	1,100	308	85	288,200	0	-100
Average			1,100 1/	308 1/	85 1/	288,200	0	-100%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease ∕ increase
TH-6040	21	1	320	200	85	54,400	0	-100%
.3 lb/gal/ac		2	440	361	93	147,721	0	-100
		3	320	323	91	94,057	0	-100
		4	730	514	87	326,441	0	-100
		5	980	952	95	234,612	0	-100
Average			558	470	90	171,446	0	-100%
Treatment Average			1,019	362	87	275,482	0	-100%

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease ∤ increase
Check	1	1	1,300	308	85	340,600	630	- 52%
		2	1,300	308	85	340,600	430	- 67
		3	1,300	308	85	340,600	700	- 46
		4	1,300	308	85	340,600	310	- 76
		5	1,300	308	85	340,600	510	- 61
Average			1,300 1/	308	85	340,600	516	- 60%
Check	2	1	850	403	91	311,720	2,670	+214%
		2	370	444	94	154,423	1,310	+254
		3	660	365	90	216,810	1,700	+158
		4	590	332	92	180,209	220	- 63
		5	1,010	354	96	343,238	90	- 91
Average			696	380	93	241,280	1,198	+ 72%
Check	3	1	6,090	233	87	1,234,503	30	- 99%
		2	1,900	213	68	275,196	0	-100
		3	1,830	113	70	144,753	50	- 97
		4	1,580	204	82	264,302	60	- 96
		5	2,500	262	87	569,850	60	- 98
Average			2,780	205	79	497,721	40	- 99%

1/ Estimated

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease / increase
Check	4	1	550	330	92	166,930	1,750	+218%
		2	460	484	89	198,149	230	- 50
		3	380	345	88	115,368	800	+110
		4	200	344	84	57,792	870	+335
		5	590	390	88	202,488	3,190	+440
Average			436	379	88	148,145	1,368	+214%
Check	5	1	2,700	241	86	559,602	2,030	- 25%
		2	2,140	192	83	341,030	2,060	- 4
		3	2,900	318	86	793,092	960	- 66
		4	2,650	147	79	307,744	530	- 80
		5	1,700	258	85	372,810	200	- 88
Average			2,418	231	84	474,856	1,156	- 52%
Check	6	1	1,120	245	84	230,496	150	- 87%
		2	6,500	269	91	1,591,135	1,300	- 80
		3	1,990	253	88	443,053	170	- 91
		4	1,380	205	87	246,123	380	- 72
		5	2,560	229	91	533,478	580	- 77
Average			2,710	240	88	608,857	516	- 81%

TABLE 4. Continued

Treatment	Plot No.	Sub Plot No.	Pre Spray em/acre	Average Number eggs/mass	% Hatch	Number larvae/acre	Post Spray em/acre	Post em population % decrease ∕ increase
Check	7	1	1,200	308	85	314,400	0	-100%
		2	1,200	308	85	314,400	20	- 98
		3	1,200	308	85	314,400	10	- 99
		4	1,200	308	85	314,400	40	- 97
		5	1,200	308	85	314,400	30	- 98
Average			1,200 1/	308	85	314,400	20	- 98%
Check	8	1	9,750	175	75	1,279,687	2,480	- 75%
		2	3,670	176	86	555,491	80	- 98
		3	2,330	167	80	311,288	70	- 97
		4	3,000	152	73	332,880	30	- 99
		5	1,090	146	79	125,720	440	- 60
Average			3,968	163	79	521,013	620	- 84%

Table 5. Gypsy Moth Larval Mortality in Dropcloths 1974

Insecticide	Plot No.	Dosage lbs a i/acre	Average accumulation of dropcloth mortality counts at end of 96 hours based on 5 subplots	
Bioethanomethrin	2	0.02	14	
	9	"	36	
	11	"	11	
Bioethanomethrin	10	0.05	58	
	16	"	6	
	13	"	60	
CGA-18809	15	0.5	154	
Encap Diazinon	14	0.5	73	
Encap Sumithion	17	1.0	66	
Imidan	1	0.5	16	
	4	"	48	
	24	"	15	
Orthene + Propolene Glycol	22	0.5	67	
	18	0.5	59	
	12	0.5	34	
Orthene + H_2O	20	0.5	109	*based on
	23	0.5	76	3 subplots
			Average at end of 144 hours	
TH 6040	3	0.06	20	40 at 168 hr
	5	"	21	38 at "
	8	"	92	
TH 6040	6	0.3	47	
	19	"	49	
	21	"	14	

Results and Conclusions

Spring egg mass densities ranged from 80 to 5550 per acre. The average number of eggs per mass per sampling unit was from 200 to 656 with a hatching percentage range of 71% to 96%. The beginning larvae population ranged from 25,004 per acre to 1,591,135 per acre. The egg masses were generally of good size, which would indicate a healthy population.

Application of materials with USDA aircraft and pilot began on May 30, 1974 and was completed on June 9, 1974. During this time 23 plots of 50 acres each were treated with chemical insecticides.

Plots 22 and 23 were sprayed on May 30 in the pm. No material was applied on May 31 because of fog, wind, and, eventually, rain. Operations resumed early afternoon on June 1. However, due to unavoidable circumstances, operations were temporarily delayed until June 6.

Spray operations resumed on June 6, 1974 with a contracted spray plane and a USDA observation plane that was used for guidance and general observation of the work.

On June 8, 1974 operations were again terminated for the day because of irresponsible flying by the pilot and failure to follow instructions. The pilot was replaced and plots 4, 12, 18, and 24 were finished on June 9.

Because of the delays in spraying, most of the target insects were in the very late 2nd or early 3rd instar. Also, foliage was almost completely expanded by the time the insecticide was applied.

The following are evaluations of efficacy data from the different chemicals tested.

Bioethanomethrin: Although an emulsifier was used in this formulation it appeared that a stable suspension was not achieved. The formulation used was not a workable field formula. A small amount of foliage protection was realized with an egg mass reduction ranging from 37 - 94%. Results were similar with both rates and dosages. The treatments did not yield the contact mortality that is customarily observed with bioethanomethrin. Work should be done with this material to find a suitable uv screening agent that can be readily used with the standard

formulation.

CGA-18809: Even after this material was mixed with water and remained within the mixing tank for 5 days before being sprayed, it gave outstanding results. Foliage protection was complete with egg mass reduction of 99%. Approximately 10 days after treatment expert ground crews were unable to find a single gypsy moth larvae within the sprayed plot. Within the untreated area surrounding the plot 100% defoliation occurred with hordes of larvae active to the edge of the sprayed area. Other insect activity in the treated plot continued to be active, indicating that the material is somewhat selective. The material mixed very well and no difficulties were encountered in dispersion. This material gave control that has not been observed with any other available or experimental insecticide. It was unfortunate that additional material was not availabel for replication. However, in 1975, CGA-18809 will be tested thoroughly with as much efficacy data as possible being compiled.

Encapsulated Diazinon: The formulation was a workable field formula for loading and dispersion. Some foliage protection was realized and egg mass reduction was 94%. Residual activity

was not as pronounced as we had hoped with this formulation.

Encapsulated Sumithion: Treatment and results were very similar to the encapsulated diazinon treatment with some foliage protection and a 74% reduction in egg masses. The foliage protection was very spotty and this was in part due to skipping by the aircraft. Days after treatment larvae were readily noticeable and considerable frass was falling within the plot.

Imidan: Little if any foliage protection was achieved with only a 24% reduction in egg masses realized. Although the material gave good laboratory results, the field results were poor. The formulation was very easy to work with.

Orthene: Formulated in water, orthene caused a 79% reduction in egg masses. In propolene glycol, a 52% reduction took place. Both formulations gave excellent foliage protection, however, a greater egg mass reduction was anticipated. No difficulties were encountered in mixing or dispersing the formulations. Instar development and foliage expansion were nearly ideal when applications were made.

TH-6040: This compound is by far the most impressive material to be tested against gypsy moth during the past decade. Egg mass reduction was 100% in all treated plots. This would indicate that a dosage lower than .06 lb/gal/A could possibly be effective. Some defoliation occurred in all plots. This was due mainly to the size of the larvae (3rd instar) when treatments were made and as a growth regulator, larval mortality does not occur until ecdysis. Three weeks after treatment there was an absence of any living gypsy moth stages within all TH-6040 treated plots. At this time they were very active in surrounding woodlands. Mortality is similar to that of virus in that the cadavers hang from the underside of foliage.

In 1975, TH-6040 will be tested thoroughly with as much efficacy data as possible being compiled. This material should be tested on 1st instar larvae if suitable foliage is available.

In summarizing the activities of 1974, it is considered that the 3 materials, Orthene + H_2O, CGA-18809, and TH-6040 may become materials useful for control of the gypsy moth and assist in protecting thousands of acres of hardwood forests.

Research involving encapsulation work with pesticides should

without question continue. However, based on 1974 field data, diazinon and sumithion may not be the most promising compounds to continue this work with. Pyrethrins or similar compounds may prove to be more workable materials.

Mention of a proprietory product in this publication does not constitute a guarantee or warranty of the product by the U. S. Department of Agriculture nor imply its approval by the Department to the exclusion of other products that may be suitable also.

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APPENDIX 1 1975 Field Evaluation of Candidate Insecticides for Gypsy Moth Control

1975 Field Evaluation of Candidate Insecticides for Gypsy Moth Control

by

Larry L. Herbaugh[1], W. H. McLane[2], C. R. Stacy[3], and J. A. Finney[4]

Abstract

Five commercial preparations of pesticides (CGA-18809, TH-6040, S-15126, SAN-197 and Sevin-4-Oil) were tested against gypsy moth larvae using various rates and formulations. Sevin-4-Oil, TH-6040 and S-15126 prevented defoliation and also caused population reduction (egg mass decline).

Introduction

Thousands of acres of forest are defoliated yearly by the gypsy moth, *Porthetria dispar* (*L.*). Because of this, investigations are conducted to evaluate different types of agents and techniques to control this pest. Presently, the most successful of these techniques is the restricted use of insecticides. Before these chemicals can be registered for use they must undergo extensive laboratory and field testing. Field trials reported here were with materials that showed minimal environmental hazard and a high potential for field use (i.e. efficaceous). These data are gathered through a screening program carried out at the USDA, Gypsy Moth Methods Development Laboratory, Otis Air Force Base, Massachusetts (McLane, 1973).

Materials and Methods

Four commercial preparations of test pesticides for gypsy moth control were field tested in 1975. These materials were selected for field testing because of the desirable characteristics demonstrated in laboratory screening. Each treatment was aerially applied to 50 acre plots (replicated 3 times) for evaluation. (See Table I for formulation). Two of the materials were field-tested in 1974. However, one was only on a limited scale and the other needed a follow-up test to substantiate its performance.

CGA-18809, an organophosphate, was field-tested in 1974 on one 50 acre plot and gave excellent foliage protection and larval mortality. Laboratory results demonstrated high activity as both a contact and a stomach poison of laboratory-reared gypsy moth larvae.

TH-6040 (Dimilin) is an insect growth regulator which was field-tested in 1974 and gave outstanding results with regard to larval mortality and egg mass reduction.

S-15126 (Malonoben) is a new class of pesticides belonging to a group called the benzylidene malononitriles. It was selected for field testing because of its performance in laboratory screening.

SAN-197, an organophosphate insecticide, also gave favorable results in laboratory tests.

Sevin-4-Oil is a carbamate insecticide currently used extensively for gypsy moth control. It was applied to three 50 acre plots at 1.0 lb ai/40 oz/acre with a 20% kerosene solvent. These plots were used as a standard with which to compare the unrigistered test materials.

Nine 50 acre plots were randomly placed throughout the treated areas so that the treated populations could be compared and evaluated against natural, untreated conditions.

Table I. Details of 1975 Formulations Field-tested

Material	Application rate/acre	Chemical Concentration	Sticker
CGA-18809			
a.	1 gal/acre	0.125 lb ai/gal	Chevron at 3% concentration
b.	1 gal/acre	0.50 lb ai/gal	"
TH-6040			
a.	1 gal/acre	0.015 lb ai/gal	Chevron at 3% concentration
b.	1 gal/acre	0.03 lb ai/gal	None
S-15126 (Malonoben)			
a.	1 gal/acre	0.125 lb ai/gal	None
b.	1 gal/acre	0.50 lb ai/gal	None
SAN-197			
a.	1 gal/acre	0.062 lb ai/gal	None
b.	1 gal/acre	0.25 lb ai/gal	None
Sevin-4-Oil	40 oz/acre	1.0 lb ai/gal	20% Kerosene (solvent)

An area in Clinton County, Pennsylvania which met the following criteria was selected for establishing study plots: 1) a building population in which there had been no more than 1 year's noticeable defoliation prior to the test year, 2) a readily measureable population within the preferred range of 100 to 900 egg masses per acre, and 3) predominance of preferred host trees (oaks).

Each 50 acre square plot was laid out by establishing an accessible base corner and plotting boundary lines along compass headings. Markers

were placed at all four corners for aircraft guidance. These markers were constructed from white canvas bags slipped over folded branches on the ends of long saplings. These saplings, in turn, were raised through the canopy and fastened so that the bags protruded about 10 feet above tree top level. Within each 50 acre plot, 5 subplots (0.1 acre) or sampling units were randomly established. These subplots were representative of the entire plot and served as sampling points throughout the experiment. Sampling points were similarly established in untreated check areas to measure natural conditions.

The application schedule was designed so that material was to be applied when the majority of the larvae were in the late second instar stage and the oak foliage was 50-75% expanded. However, due to rains and extra warm weather the week prior to spraying, leaf expansion on preferred host plants was about 80%.

Materials were mixed and transferred into the aircraft with conventional equipment (mixing tank, pumps, hoses, measuring devices, and necessary safety equipment). All mixing and spraying equipment was thoroughly cleaned between each treatment to avoid adulteration. Radio communications were maintained between the ground crew and the spray plane with respect to ground conditions of wind velocity and materials dispersement. Application quality and dispersement was checked by placing red Kromekote cards on wire stands in each sampling unit. These were

placed just prior to spraying and removed for evaluation immediately after treatment. When possible, cards were used on woods roads to get information at the time of application.

All plots were treated with a Piper Pawnee aircraft equipped with a propeller-driven impeller pump and a conventional spray system (Table II). The airplane dispersed the material in 75 foot swaths at 100 mph as near to tree top level as possible with a ground wind velocity of less than 5 mph.

Table II. Configuration of spray systems utilized

Material	Orifice	Screen Mesh	psi	Degree to Slipstream
CGA-18809	D8-Hollow cone with 45° swirl plate	25 mesh	40	90
TH-6040(Dimilin)	"	"	40	90
S-15126(Malonoben)	"	"	40	90
SAN-197	"	"	40	90
Sevin-4-Oil	8002	50 mesh	40	90

Each treatment was evaluated from the standpoint of foliage protection, em/acre reduction and dropcloth mortality.

Foliage protection was determined from visual estimates of the degree of defoliation in each of the sampling plots at the termination of

larval feeding. These estimates were made in 20% increments and rated low, medium, and high, within the increment. Estimates were all performed by the same crew so that human judgement would remain constant. For computation purposes, the figures 7, 14, 20...87, 94, 100, were assigned as low, medium and high percentagees.

Each treated plot was measured against its corresponding geographic check and the average of these tabulations gave the percent reduction in defoliation (Fig. 2).

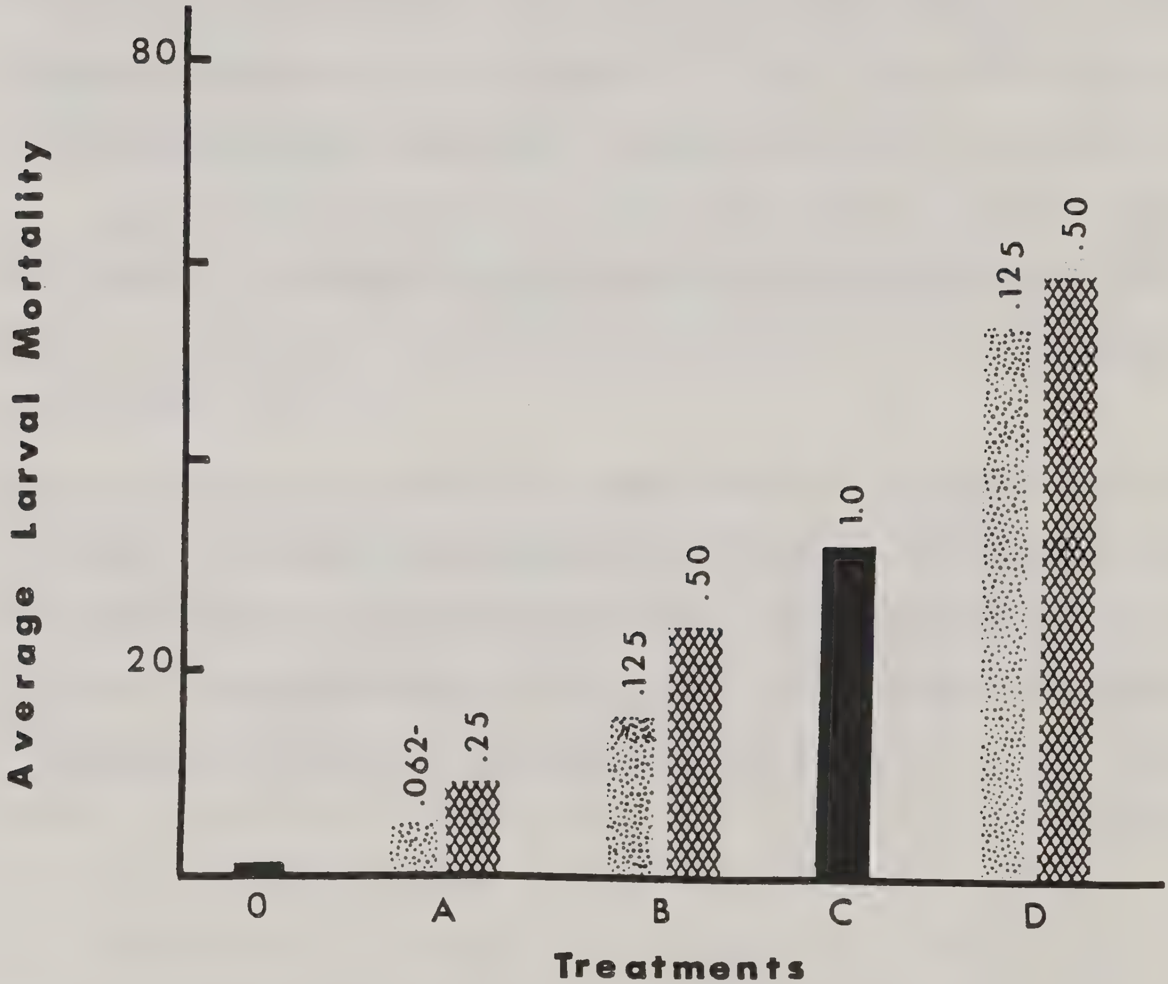
Each subplot was intensively surveyed in early spring to determine the number of egg masses/acre before treatment. Egg masses were collected adjacent to the sampling plots and were stratified to represent above and below the snowline. These collections were incubated in the laboratory to provide the following data: number of eggs/mass, number of larvae successfully hatched, and the percent hatch for each egg mass. An estimate of beginning larval population was computed by: (number egg mass/acre)(number eggs/mass)(percent hatch) = number of beginning larvae per acre.

The percent change in egg mass population was calculated after counting the egg masses in each subplot after leaf drop (Table III).

To determine residual effects on larval mortality, a 3' x 3' white drop cloth was placed under a representative host tree in each of the sampling

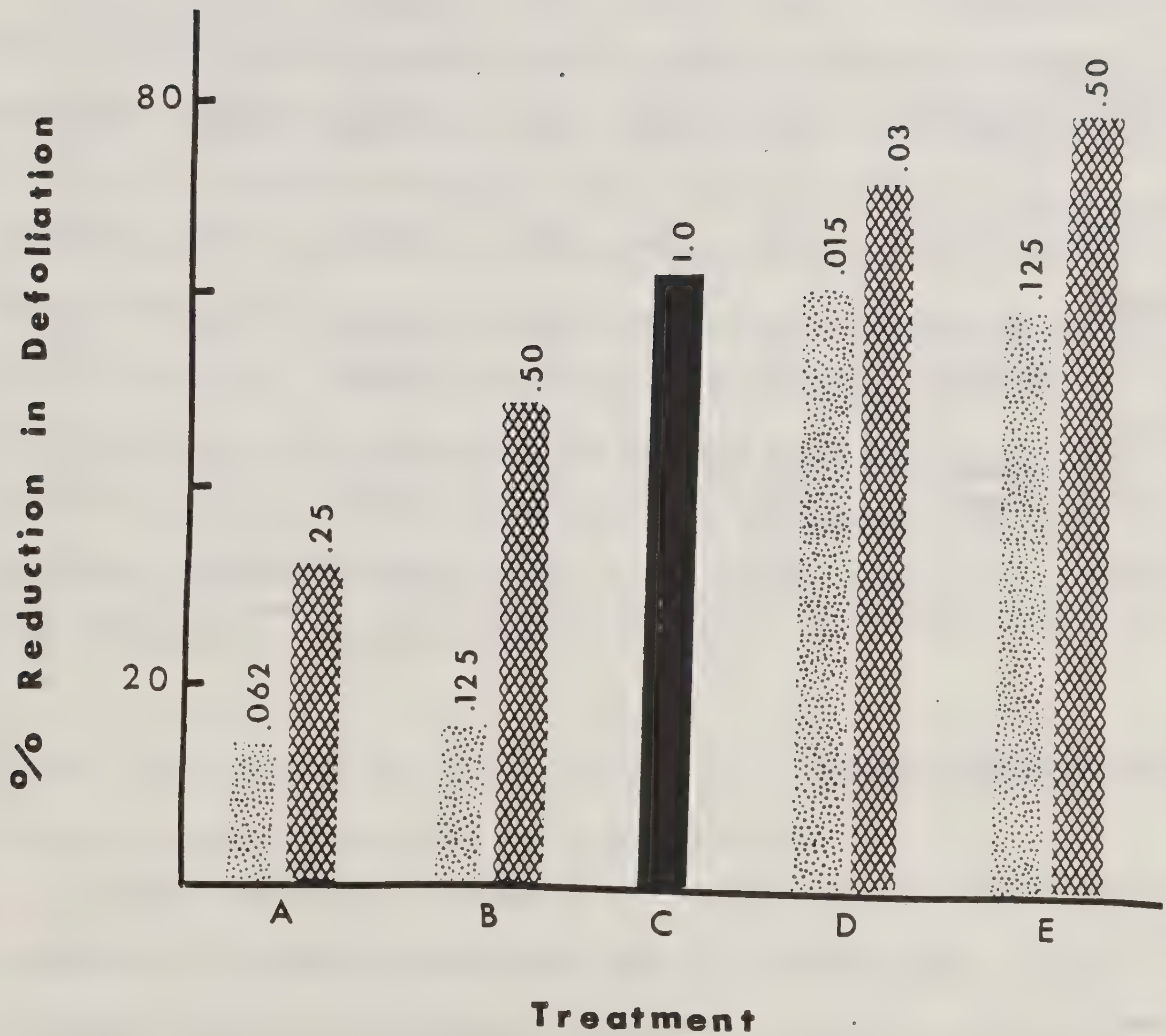
units. Daily readings were made and recorded on each of these until mortality ceased to be significant. This occurred in all cases in 96 hours or less (see Fig. I). No drop cloths were placed in TH-6040 plots because of its mode of action. The cadavers are similar to those infected with virus and tend to remain attached to the host plant, making dropcloth counts unreliable as indicators of larval mortality.

Application quality and dispersement was checked by placing red Kromekote cards on wire stands in each sampling unit. These were placed just prior to spraying and removed immediately after the plot was sprayed for determinations. When possible, these cards were used on woods roads to get immediate information as the pilot was spraying the plot.



Larval mortality as determined by 3' x 3' dropcloth counts (96 hr. accumulation).

O = Check A = SAN-197 B = CGA-18809
C = Sevin-4-Oil D = S-15126



Reduction in defoliation calculated from defoliation in adjacent check plots.

A = SAN-197 B = CGA-18809 C = Sevin-4-Oil
D = TH-6040 E = S-15126

Table III. Population Trends (Treatment Average)

Treatment	Pre-Spray em/A	No. eggs/mass	% Hatch	Pre-spray Larvae/A	Post-spray em/A	% Change in em/A
SAN-197						
.062 lb ai/gal/A	512	440	82	102,207	1490	+291
.25 lb ai/gal/A	417	321	78	111,523	1072	+257
CGA-18809						
.125 lb ai/gal/A	348	346	80	94,870	1537	+441
.50 lb ai/gal/A	517	348	77	145,800	1036	+200
Sevin-4-Oil						
1.0 lb ai/40 oz/A	436	344	82	133,420	118	-73
TH-6040						
.015 lb ai/gal/A	385	414	84	140,549	80	-80
.03 lb ai/gal/A	562	385	79	155,002	3	-99
S-15126						
.125 lb ai/gal/A	484	426	85	179,549	754	+155
.50 lb ai/gal/A	355	363	81	93,006	95	-74
Checks	383	394	80	119,342	1597	+416

Results and Conclusions

Treatment applications began on May 28 and were completed on June 2, 1975 using a USDA aircraft. During this period of time, 5 different chemicals were sprayed in 25 plots of 50 acres each in central Pennsylvania. During this period rain showers experienced on the night of May 29 and during the day on May 30. Severe isolated thunderstorms hit the plot area at 3 pm May 31 and rain continued until early after-

noon on June 1. Because of the rain, no plots were treated on May 30 and Sunday June 1. No problems or delays were encountered while mixing the materials and no mechanical problems were confronted.

Pre-treatment densities ranged from 80 to 1940 egg masses per acre. The average number of eggs per mass per sampling unit was from 145 to 817 with a hatching percentage range of 42 to 99. The beginning larval population ranged from 17,589 per acre to 610,324 per acre. The egg masses were generally of good size, which would indicate a healthy population. Observations showed that the target insects ranged from 1st to 3rd instar with the majority being 2nds at the time of treatment. However, due to rains and unseasonably warm weather the week before spraying, the leaves on host trees were about 90% expanded at treatment time.

Efficacy conclusions of the different chemicals tested were based on the results shown in Table III, and Figures I and II.

SAN-197 gave no reduction in egg mass density/acre; in fact it showed an increase similar to the untreated checks. It showed a low larval mortality in the drop cloths as well as very little foliage protection. Because of these facts, this material will not receive any immediate future field testing.

CGA-18809 was very similar to SAN-197 in the resulting egg mass density/acre after treatment. It did show some larval mortality and foliage

protection but even at the 0.50 lbs ai/acre the results were lower than the standard of Sevin-4-Oil. This material has been temporarily discontinued by the company for future field testing on gypsy moth larvae.

Sevin-4-Oil gave a good reduction in egg mass density/acre, a higher larval mortality and a higher degree of foliage protection than the two previous mentioned materials. However, it gave less larval mortality than S-15126 and less foliage protection than either TH-6040 or S-15126 at the higher dosages per acre.

TH-6040 gave outstanding reductions in egg mass density as well as good foliage protection. This material is presently going through channels for registration against gypsy moth larvae. Future field testing is anticipated.

S-15126 at 0.50 lb ai/acre gave excellent reduction in egg mass density/acre. It also showed a high larval mortality count as well as giving excellent foliage protection. However, this material has been temporarily removed from future field testing against gypsy moth larvae by the producers.

Of the five chemicals tested in 1975, only TH-6040 (now called Dimilin) will receive any field testing in the 1976 program.

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District No. 7 of the Pennsylvania Bureau of Forestry

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Footnotes

1/ L. L. Herbaugh - Agriculturist, USDA, APHIS, Otis AFB, MA

2/ W. H. McLane - Biological Technician, USDA, APHIS, Otis AFB, MA

3/ C. R. Stacy - Biological Technician, USDA, APHIS, Otis AFB, MA

4/ J. A. Finney - Biological Aid, USDA, APHIS, Otis AFB, MA

Laboratory Screening of Candidate Pesticides
and Microbials Against the Gypsy Moth
October 1, 1986 - September 30, 1987

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Project Number: GM 8.1.3
Project Title: Laboratory Screening of Candidate Pesticides and Microbials Against the Gypsy Moth
Report Period: October 1, 1986 - September 30, 1987
Report Type: Interim
Project Leaders: W. H. McLane and J. A. Finney

The objectives of this laboratory screening project are to collect and evaluate mortality data on experimental and registered compounds potentially useful for gypsy moth control, and to select materials for field studies and further development. These tests are designed to identify new materials and to increase the effectiveness of registered products.

Our main emphasis is development of new and registered materials that may improve treatments of gypsy moth in isolated infestations.

Unless otherwise stated, all tests have been conducted with our standard red oak seedling technique. Test insects are of the New Jersey strain and have been laboratory reared on artificial diet.

During 1987, Bacillus thuringiensis (Bt) and Dimilin were the insecticides of choice for gypsy moth control. A considerable amount of Dimilin treated woodlands were treated prior to larvae maturing to 2nd instar and with foliage development of less than 15 percent. Bt was applied at 12, 16 or 20 BIU/acre in a gallon or more of water. A new strain of Bt (Condor) was field tested on a limited basis.

New strains of Bt were tested in the laboratory as well as strains of Beauveria bassiana.

Laboratory tests were conducted with 3 Dimilin formulations. Oak seedlings and newly moulted 2nd instar gypsy moth larvae were used.

Table 1. Percent mortality os 2nd instar gypsy moth larvae and oak seedling defoliation following a 4 and 6 day exposure to foliage treated with Dimilin 25W and 2 separate samples of Dimilin 2F.

Formulation	lbs. AI/gal/ac	Inches rain	After 4 days mor.	After 4 days def.	After 6 days mor.
25W	.0312	-	49	77	100
	.0312	.25	73	81	96
	.0156	-	59	84	100
	.0078	-	63	63	99
2F	.0312	0	68	83	99
	.0312	.25	60	82	98
	.0156	-	56	81	98
	.0078	-	54	81	84
2F (Sample 2)	.0312	-	17	76	22
	.0312	.25	26	89	28
	.0256	-	0	88	1
	.0078	-	0	83	0
CHECK	-	-	0	80	1

Dimilin 2F was compared to Dimilin 25W when exposed to 1.0 inches of rain 2 hours after treatment. This study was replicated 20 times.

Table 2. Percent mortality of 2nd instar gypsy moth larvae following exposure to Dimilin 25W and Dimilin 2F applied to oak foliage at .0312 lbs. AI/gal/acre.

Formulation	Inches rain	After 3 days mortality	After 5 days mortality	After 10 days mortality
25W	-	62	94	100
	1.0	58	97	100
2F	-	51	87	100
	1.0	51	98	100
CHECK	-	0	0	3

Table 3. Percent mortality of 2nd instar gypsy moth larvae following exposure to oak foliage treated with 3 Dimilin formulations at .0312 lbs. AI/gal/acre.

Formulation	Inches rain	After 3 days mortality	After 7 days mortality	After 10 days mortality
25W	-	47	98	100
	1.0	47	98	99
	2.0	65	100	-
	3.0	63	100	-
2F	-	43	96	100
	1.0	51	98	100
	2.0	57	99	100
	3.0	59	100	-
4F	-	62	99	100
	1.0	68	100	-
	2.0	65	98	100
	3.0	66	100	-
	-	0	0	5
CHECK	3.0	0	4	5

At our request, Uniroyal made up special samples for "neat" applications. Two samples were tested in the laboratory and gave excellent results. Sample 1 was formulated at .0625 lbs. AI/qt. and Sample 2 at .0312 lbs. AI/qt.

Table 4. Percent mortality of 2nd instar gypsy moth larvae following exposure to oak foliage treated with neat applications of 2 Dimilin formulations.

Formulation	lbs. AI/qt/acre	Inches rain	After 4 days mortality	After 7 days mortality
Sample 1	.0625	-	48	100
	.0625	.5	29	100
	.0625	1.0	46	100
	.0625	2.0	52	100
	.0625	3.0	54	99
	.0625	5.0	39	99
Sample 2	.0312	-	68	100
	.0312	.5	52	98
	.0312	1.0	56	95
	.0312	2.0	70	97
	.0312	3.0	57	96
	.0312	5.0	62	99
CHECK	-	-	8	10
	-	5.0	0	0

Malathion ULV and Malathion CR (United-Ag-Products) were tested in the laboratory. Tests were conducted with our standard red oak seedling technique with 2nd instar, laboratory reared, gypsy moth larvae used as test insects. Each treatment was replicated 5 times with 20 larvae exposed to each plant. Tests were conducted at a temperature of 80° F and 55% RH.

Plants that were exposed to rain in our laboratory weathering chamber received 2 hours of drying time following treatment and before rain exposure. In some cases, a greater drying time was used, as noted.

1987 Field Trials with Early Dimilin
Applications in West Virginia
October 1, 1986 - September 30, 1987

Project Number:	GM 5.1.1
Project Title:	1987 Field Trials with Early Dimilin Applications in West Virginia
Report Period:	October 1, 1986 - September 30, 1987
Report Type:	Final
Project Leaders:	W. H. McLane, T. Roland, B. Tanner, J. Hacker, N. Schneeberger and P. Bohne

The Animal Plant Health Inspection Service, Forest Service, W VA Department of Agriculture and Uniroyal Chemical cooperated in a study to determine the usefulness of early applications of Dimilin for gypsy moth control. Similar tests were conducted in 1986 with smaller acreage plots.

Three 5,000 acre plots were established west of Martinsburg, West Virginia. One plot was sprayed as soon as gypsy moth egg hatch was observed on one or more egg masses with a southerly exposure (Treatment 1). This treatment was started on April 20th and completed on the 22nd. There was no foliage on any of the tree species when treatment was made. A second plot was treated at time of general hatch, May 1 - May 5th (Treatment 2). At that time, 90> percent of visible egg masses had hatched out. About half of the newly hatched larvae had left the egg mass and the rest remained on the mass. Buds on white oak had just opened up and foliage on other oaks was approximately 5 percent expanded. A third plot was used as an untreated control (Treatment 3).

Two Dimilin formulations were applied, 25W and 2F. Each was treated with .031bs. AI/gallon/acre with water as a carrier. Half of each plot received 25W and the remainder was sprayed with 2F. No sticker or other material was added to the formulations.

The material was applied with Cessna Ag truck aircraft equipped with 8004 Tee Jet flat fan nozzles. The aircraft dispersed the material at a speed of 120 mph, 50 feet over the tree tops. A pressure of 40 psi was used with a 75 foot swath. All material was applied during the morning hours.

A number of techniques were used to evaluate this study. Pre- and post-spray egg mass counts were made as well as defoliation estimates. Burlap was placed around oak trees at 25 sites within each experimental plot. Larval and pupal counts were made under each burlap at 5 time periods following treatment.

Based on total larval and pupal counts for the 5 readings, the treatment applied at general hatch time gave excellent control. The application made at first hatch gave fair results. Healthy numbers of larvae and pupae were recorded in the control plot. The first hatch treatment recorded 65 percent less total larvae than the control. The application at general hatch had 91 percent less larvae than the control plot. The differential in total pupae numbers was 59 and 98 percent respectively.

Defoliation, computed from data collected at each of 25 sites within each plot, demonstrated the effectiveness of the treatment made at general hatch. When collected, defoliation data were grouped into 20% increments. All estimates within the general hatch treatment plot were in the lower end of the 0-20% bracket. The early treatment also produced good foliage protection (27%

defoliation) when compared with 45% in the check plot.

Statistically, there was no difference between pre- and post-season egg mass counts in the 10% hatch plot treatment and the check. In the plot treated at general hatch time, post-treatment egg mass counts were statistically lower than the pre-treatment counts. In the untreated check post-treatment egg mass counts were statistically higher than in pre-treatment counts.

Based on early Dimilin treatment data from the past 2 years of studies, we recommend that Dimilin can be applied successfully starting at general gypsy moth egg hatch time. Uniroyal is presently in the process of obtaining approval for a label change. The new label will address our early treatment recommendation.

Although treatments made at first hatch time have demonstrated foliage protection and egg mass reduction, we feel additional data still need to be collected and analyzed before recommendations can be made.

This was a cooperative project and conducted by:

W. McLane, USDA, APHIS, Bldg. 1298, Otis AFB, MA 02542

T. Roland and B. Tanner, USDA, APHIS, Aircraft Operations, Moore Air Base, Edinburg, TX 78539

J. Hacker and A. Miller, W VA Dept. of Agriculture, Charleston, W VA 25305

P. Bohne, Uniroyal Chemical, Apple Hill Rd., Bennington, VT 05201

N. Schneeberger, USDA, FS, P.O. Box 4360, Morgantown, W VA 26505

Table 1. Recorded defoliation, larvae and pupae under burlaps in each treatment and control plot.

Treatment	Total live larvae under burlaps	Total pupae under burlaps	Percent defoliation
I	4,854	4,416	21
II	1,224	208	10
III	13,723	10,801	45

I - Treatment applied when 10% hatch.
II - Treatment applied when 100% hatch.
III - Control (untreated).

Table 2. Statistical analysis of pre- and post-treatment egg mass counts.

Treatment	Type	N	Mean	SD	Minimum	Maximum
I	pre	26	1,659	3,421	0	15,188
	post	26	907	782	35	2,605
II	pre	96	1,942	2,899	0	14,880
	post	96	381	583	0	3,560
III	pre	127	2,088	7,263	0	42,240
	post	127	3,627	4,316	40	33,200

I - Treatment applied when 10% hatch.
T = -1.09 PROB = 0.28
II - Treatment applied when 100% hatch.
T = 5.17 PROB = 0.00
III - Control (untreated)
T = -2.05 PROB = 0.04

Table 3. Pre- and post-treatment egg mass distribution.

	Type EM	Treatment I	Treatment II	Treatment III
Percent of sub-sampling sites with 0 EM/acre	pre	8-(2 of 26)	10-(10 of 96)	52-(66 of 127)
	post	0	20-(19 of 96)	0
Percent of sub-sampling sites with 1-50 EM/acre	pre	4-(1 of 26)	4-(4 of 96)	6-(8 of 127)
	post	8-(2 of 26)	8-(8 of 96)	1-(1 of 127)

I - Treatment applied when 10% hatch.
II - Treatment applied when 100% hatch.
III - Control (untreated).

TOTAL LIVE LARVAE FROM BANDS

TREATMENT	TIME 1	2	3	4	5	TOTAL
1	389	127	3342	869	127	4854
2	235	488	242	207	52	1224
3	1279	3495	5681	2189	1079	13723

TOTAL NUMBER OF PUPAE FROM BANDS

	TIME					
TREATMENT	1	2	3	4	5	TOTAL
1	0	300	879	3042	195	4416
2	0	28	11	125	44	208
3	0	254	2235	6810	1502	10801

WEIGHTED AVERAGE DEFOLIATION PER TREATMENT

TREATMENT 1 = 21%
TREATMENT 2 = 10%
TREATMENT 3 = 45%

NUMBER OF PLOTS WITHIN TREATMENT BLOCKS

TREATMENT	NUMBER OF PLOTS
1 (10% EGG HATCH)	26
2 (100% EGG HATCH)	96
3 (CHECK)	127

10% EGG HATCH (T1)

COMPARISON OF PRE- AND POST-TREATMENT EM COUNTS

	N	MEAN	SD	MIN	MAX
PRE	26	1659	3421	0	15188
POST	26	907	782	35	2605

T = 1.09

PROB = 0.28

100% EGG HATCH (T2)

COMPARISON OF PRE- AND POST-TREATMENT EM COUNTS

	N	MEAN	SD	MIN	MAX
PRE	96	1942	2899	0	14880
POST	96	381	583	0	3560

T = 5.17

PROB = 0.00

CHECK (T3)

COMPARISON OF PRE- AND POST-TREATMENT EM COUNTS

	N	MEAN	SD	MIN	MAX
PRE	127	2088	7263	0	42240
POST	127	3627	4316	40	33200

T = -2.05

PROB = 0.04

TREATMENT	PERCENT OF PLOTS WITH 0 EM/ACRE, PRETREATMENT	PERCENT OF PLOTS WITH 0 EM/ACRE, POST-TREATMENT
1	8 (2 OF 26)	0
2	10 (10 OF 96)	20 (19 OF 96)
3	52 (66 OF 127)	0

TREATMENT	PERCENT OF PLOTS WITH 1-50 EM/ACRE, PRETREATMENT	PERCENT OF PLOTS WITH 1-50 EM/ACRE, POST-TREATMENT
1	4 (1 OF 26)	8 (2 OF 26)
2	4 (4 OF 96)	8 (8 OF 96)
3	6 (8 OF 127)	1 (1 OF 127)

Laboratory Screening of Candidate Pesticides
Against the Gypsy Moth
October 1, 1977 - March 31, 1978

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Project Number: GM 8.1.3
Project Title: Laboratory Screening of Candidate Pesticides Against the Gypsy Moth
Report Period: October 1, 1977 - March 31, 1978
Report Type: Interim
Project Leaders: Winfred H. McLane, J. A. Finney

The primary objective of this laboratory screening project is to collect mortality data on registered and experimental compounds and formulations potentially useful against all stages of the gypsy moth, evaluating this data and selecting suitable materials for field testing.

The following tests were conducted using the standard oak seedling technique.

Table 1. Comparing an oil formulation of Dimilin® to a water formulation using 25 w/p in both mixes.

	Percent Mortality		
Dosage	Orchex oil	Water	Days after treatment
0.0001 lb. AI/gal/AC	75	49	8
0.0004 lb. AI/gal/AC	90	93	8
0.0009 lb. AI/gal/AC	100	100	8
0.0039 lb. AI/gal/AC	100	100	8
0.0156 lb. AI/gal/AC	100	100	8
0.0625 lb. AI/gal/AC	100	100	8
Check	3	3	8

There appeared to be no substantial difference between the two mixes when tested under laboratory conditions using second instar gypsy moth larvae. However, at the lowest dosage the oil formulation did give superior results.

A number of tests were conducted using Rhoplex® and Target® NL stickers. The tests were conducted to determine the effectiveness of Target NL when used with Imidan® and Sumithion®.

Table 5. Test results using two experimental formulations of Dimilin®

Material	Dosage	Percent Mortality Emul+oil+H_2O 1/	Savol oil+H_2O 2/	Days after Treatment
Dimilin	0.25 lb.AI/gal/AC	100	100	11
"	0.06 lb.AI/gal/AC	100	100	11
Check	-	0	0	11

1/ 49% H_2O - 49% Orchex oil - 2% Triton X-190

2/ 50% Savol - 50% H_2O

A bioassay was made on a DDT sample for V. LaFleur.

Table 6. Results of bioassay on DDT sample.

Material	Dosage	Percent Mortality	Days After Treatment
DDT	2.0 lb.AI/gal/AC	100	5
"	1.0 lb.AI/gal/AC	98	5
"	0.5 lb.AI/gal/AC	100	5
"	0.2 lb.AI/gal/AC	100	5
Check	-	0	5

1977 Field Studies of Dimilin W-25
October 1, 1977 - March 31, 1978

Project Number: GM 7.1.7
Project Title: 1977 Field Studies of Dimilin W-25
Report Period: October 1, 1977 - March 31, 1978
Report Type: Final
Project Leaders: Larry L. Herbaugh, W. H. McLane, J. A. Finney

One function of this laboratory is to field test materials of different formulations at various rates and times of application (insect growth, leaf expansion, etc.) to derive the maximum benefits from compounds used in the control of gypsy moth larvae. Therefore, these tests were designed to establish an economical and satisfactory dosage for regulatory control and develop an eradication treatment for isolated infestations of gypsy moth using Dimilin. Dimilin (TH-6040) N(((4-chlorophenyl)-amino)carbonyl)-2,6-difluorobenzomide has received considerable attention in recent years as an insect growth regulator which inhibits the deposition of chitin in gypsy moth larvae. It is presently registered for controlling gypsy moth larvae by aerial applications of .03 lb ai/A to .06 lb ai/A.

Objectives:

1. Determine the activity and compare the efficiency of Dimilin W-25 applied at a single application for use in regulatory treatment of hazardous areas.

2. Determine the relative utility for eradication of infestations using several different treatment schedules of Dimilin W-25.

Objectives and methods are explained in detail in Project Number GM 7.1.7 dated October 1, 1976 - March 31, 1977.

Results and Discussion:

Each treatment plot evaluated for eradication had 200 burlap bands distributed in the center 10 acres (total of 600 bands per treatment). Table 1 gives the totals for each treatment. It should be noted that the 16 pupae found in plots treated with Dimilin at 0.06 lb/gal/A were all under two burlap bands and may be due to migration or wind spread. Table 1 also shows a trend toward multiple applications being more effective against gypsy moth larvae. For example, the single application of Dimilin at 0.06 lb/gal/A yielded 448 larvae under 600 bands compared with 0 larvae using the same dosage with two applications. Dimilin at 0.03 lb/.5 gal/A at two applications yielded 17 larvae under 600 bands compared with 0 larvae at three applications.

Table 1. Larval, Pupal and Egg Mass Counts from Burlap Band Monitoring, Pike County, PA 1977. (Numbers are totals from 600 bands distributed in 3 plots).

Dosage	# of Applications	Number Larvae	Number Pupae	Number of Egg Masses
0.06 lb/gal/A	1	448	26	0
0.06 lb/gal/A	2	0	0	0
0.06 lb/.5 gal/A	2	59	0	0
0.03 lb/gal/A	2	12	0	0
0.03 lb/.5 gal/A	2	17	0	0
0.03 lb/.5 gal/A	3	0	0	0
0.03 lb/gal/A	3	0	0	0
Check	None	25,157	12,060	1,121

Each center 10 acre plot was surveyed both pre-and post spray for egg masses. This egg mass survey was accomplished using the diagnostic prism method developed by the USFS. Table 2 reflects the average egg mass populations for 1977 treatments.

Table 2. 1977 Prism Point Egg Mass Counts, Pike County, PA (average of 3 plots)

Dimilin Dosage	# of Applications	# Spring Egg Masses/A	# Fall Egg Masses/A
0.06 lb/gal/A	1	711	0
0.06 lb/gal/A	2	1788	0
0.03 lb/gal/A	2	1883	0
0.03 lb/gal/A	3	636	0
0.06 lb/.5 gal/A	2	1630	0
0.03 lb/.5 gal/A	2	841	0
0.03 lb/.5 gal/A	3	1592	0
0.06 lb/.5 gal/A	1	1063	0
0.03 lb/.5 gal/A	1	1509	0
Checks (average of 10 plots)	None	1994	910

Visual defoliation estimations were made at pre-spray and at peak defoliation in increments of 20%. In all cases the pre-spray estimates fell within the 0 - 20% defoliation range. Post spray estimates also fell within 0 - 20% for the treated areas whereas the checks fell in a range from 60 - 100% defoliation.

All rates and dosages of Dimilin W-25 applied by air in 1977 to forested areas gave excellent foliage protection. These same formulations caused egg mass populations to be reduced to a "non-detectable" level using current survey expertise.

Dimilin (diflubenzuron) Review

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Dimilin (diflubenzuron) Review

Win McLane

Introduction

Dimilin belongs to a novel group of insecticidal compounds, the substituted 1-benzoyl-3-phenylureas, discovered by DUPHAR B.V., Holland.

Dimilin acts by interfering with the deposition of chitin, one of the main components of the insect cuticle. After treatment with Dimilin, larvae have difficulties with moulting. The malformed cuticle of the new instar cannot withstand the internal pressure during ecdysis and/or cannot give sufficient support to the muscles involved. This results in an inability to cast the exuviae and finally leads to the death of the larva. The mode of action of Dimilin can also give rise to ovicidal effects by interfering with chitin deposition of the developing larva in the egg. Adult insects are not lethally affected. Dimilin is mainly a stomach poison, but in some cases contact toxicity is also of importance. The compound is not plant-systemic and does not penetrate into the plant tissue. Consequently, sucking insects will not, as a rule, be affected; these characteristics form the basis of a further selectivity within the order of insects. Dimilin has a high stability on plants and a favorable degradation pattern in water and in soil.

Dimilin is of low mammalian toxicity. The product should be handled and used with the normal care and caution that should be exercised in dealing with pesticides. Excessive contact should be avoided.

Much of the success of Dimilin can be attributed to its effectiveness. The unique properties of Dimilin combine with the gypsy moth's life cycle to make it a very precise and highly selective product.

As treated larvae behave and feed normally until a molt is due, some plant damage can still occur after application. But early treatment should keep this to a minimum.

Dimilin can cause ovicidal effects by contact on gypsy moth eggs or by treatment of gravid females. In both cases, the larva in the egg is fully developed and alive but, due to the chitin deficiency in the cuticle, it is either unable to hatch, or it dies soon after.

The diflubenzuron residue on plants is relatively persistent and stable. It does not enter plant cells and is not easily washed off by rain. This is an advantage as it offers long-lasting insecticidal protection to the plant while having no harmful side-effects.

Dimilin, when used according to the instructions on the label, is the most effective pesticide available against gypsy moth.

Dimilin was first tested against gypsy moth larvae at the USDA, APHIS, Otis Methods Development Center laboratory in 1973 (McLane, Laboratory Report). The material was called TH-6040 and was distributed by Thompson Hayward. Initial testing demonstrated its exceptional effectiveness against gypsy moth larvae at very low dosages.

In 1974, TH-6040 was field tested on 50 acre spray plots by USDA, APHIS in Hamden County, Massachusetts (Herbaugh, McLane Laboratory Report, July - December, 1974). Dosages of .3 lbs. AI/gallon/acre (5 oz. AI) and .06 lbs. AI/gallon/acre (1 oz. AI) were tested and resulted in 100 percent population reduction based on pre- and post-egg mass counts. It was noted that mortality did not occur until about 6 days post-treatment.

In early 1975, TH-6040 was given the name Dimilin. At this time two formulations were available for experimental testing, Dimilin 25W and Dimilin 2F.

Laboratory and field testing of Dimilin 25W continued during 1975. Laboratory studies (McLane, Laboratory Reports, January - August, 1975 and September - March 1975-1976) confirmed its ability to resist wash-off when exposed to rainfall as well as its efficacy at low dosages.

Field tests (Herbaugh and McLane, Laboratory Report, September, 1975 - March, 1976) demonstrated its effectiveness against early 2nd instar gypsy moth with larvae at dosages of .03 lbs. AI/acre (.5 oz. AI) and .015 lbs. AI/acre (.25 oz. AI).

During the early and mid seventies there were less than desirable results being achieved with most application of *Bacillus thuringiensis*, Bt. The state of Pennsylvania continued to use Trichlorfon (Dylox) and some carbaryl (Sevin) was used by states like New Jersey.

Mainly through the efforts of the USDA, APHIS, Otis Methods Development Center laboratory and John Kennedy, APHIS, Hyattsville staff officer, Dimilin 25W was registered for gypsy moth control on April 19, 1976.

Uniroyal Chemical Company started marketing Dimilin in 1981. Thompson Hayward were no longer involved with the development or sales of Dimilin.

In 1978, approximately 2,500 acres of isolated gypsy moth infestation was treated with two applications of Dimilin 25W in San Jose, California. The treatments were applied at .03 lbs./AI gallon/acre (.5 oz. AI) and resulted in 100 percent control based on post-treatment pheromone trapping surveys.

Six hundred acres were treated with two applications of Dimilin 4L for gypsy moth eradication in northwest Arkansas during 1993. Populations in the core (10 acres) area averaged about 10,000 egg masses per acre. The material was applied by helicopter at .03 lbs. AI/gallon/acre and gave excellent control results within the treatment area. No larvae were found under burlap (150 trees in core area) placed around trees during the post-treatment larval period. Only one male moth was captured by pheromone traps (60 traps) during the flight period following the treatments.

During the past 17 years, Dimilin 25W and more recently Dimilin 4L (past 3 years) have been used in gypsy moth suppression projects in the northeastern United States. For the past 10 years, nearly half of the total acres treated for suppression projects have been sprayed with Dimilin (Twardus, Database, 1993). However, less Dimilin has been used in recent years (past 3) because of its disputed effect on the environment.

From the time of registration until present, Dimilin has continued to be evaluated. Studies conducted include its effects on non-target insects, effects on aquatics, its residual, wash-off characteristics, efficacy, evaporation, drift and formulation evaluation, to name a few.

Presently Dimilin can be used to protect trees and shrubs against gypsy moth in such areas as:

- Forests
- Residential, municipal and shade tree areas
- Recreational areas, such as campgrounds, golf courses, parks, parkways
- Ornamental, shade tree and forest nurseries
- Forest plantings
- Shelterbelts
- Rights of way and other easements

Dimilin is a restricted use pesticide, mainly because of its effects an aquatics.

Dosage/Rate Used

Both Dimilin 25W (EPS Reg. No. 37100-8-400) and Dimilin 4L (EPA Reg. No. 37100-54-400) are registered for use at .25 to 1.0 ounces of active ingredient per acre when used against gypsy moth larvae. This amounts to 1-4 ounces and .5 to 2 ounces of formulation, respectively.

The active ingredient of Dimilin 25W is 25 percent with 75 percent being inert ingredients. With Dimilin 4L, the active ingredient is 40.4 percent with 59.6 percent inert ingredients.

Dimilin 25W

Insect	Rate Dimilin 25W Per Acre	Timing	Spray Volume Per Acre-Gallons		
			Aerial	Ground	
				Air Blast	Hydraulic
Gypsy Moth	1-4 oz.	Early instar (1st, 2nd or 3rd preferred, but prior to full leaf expansion.	0.5-2.5	5-20	100-400

Dimilin 4L

Insect	Rate Dimilin 4L Per Acre	Timing	Spray Volume Per-Gallons		
			Aerial	Ground	
				Air Blast	Hydraulic
Gypsy Moth	0.5-2 oz.	Early instar (1st, 2nd or 3rd) preferred, but prior to full leaf expansion.	0.5-2.5	5-20	100-400

For standard suppression programs, no more than one application is allowed per year. For quarantine programs, two applications are allowable but total amount applied per season should not exceed 2 ounces of Dimilin 4L or 4 ounces of Dimilin 25W.

In nearly all suppression programs and private spray programs, Dimilin has been used at .03 lbs. AI (.5 oz. AI)/gallon/acre. This requires 2 ounces of Dimilin 25W or 1 ounce of Dimilin 4L per acre. For eradication projects, the material has been applied at .03 lbs. AI (.5 oz. AI)/gallon/acre using 2 applications 7 to 14 days apart. Both techniques have been very effective at controlling extremely light and heavy population of gypsy moth larvae.

There have been a number of laboratory studies and some field studies using lower dosages and rates.

Laboratory (Otis)

Dosage/Rate	Mortality	Reference
.0001 lbs. AI/A (.0017 oz. AI)	75%	McLane, Lab. Reports October - March 1977-1978
.0009 lbs. AI/A (.015 oz. AI)	100%	McLane, Lab. Reports April - September 1977
.003 lbs. AI/A (.062 oz. AI)	100%	McLane, Lab Reports September - March 1975-1976

Numerous laboratory studies similar to the ones reported have been done at the Otis Methods Development Center, USDA, APHIS. All demonstrate excellent efficacy (100 percent mortality) at one-hundredth of an ounce when newly moulted 2nd instar larvae are exposed to treated oak seedlings.

Field studies have demonstrated that Dimilin can be applied effectively at .03 lbs. AI (.5 oz. AI) using reduced volumes of application.

Field (Otis)

Dosage/Rate	Population Reduction	Reference
.03 lbs. AI/.5 gal./A (.5 oz. AI)	100.%	Herbaugh, McLane Lab. Reports April - Sept. 1977
.03 lbs. AI/.25 gal./A (.5 oz. AI)	99.%	McLane, Lab. Reports April - September 1979
.03 lbs. AI/.5 gal./A (.5 oz. AI)	99.%	McLane, Lab. Reports October 1987 - September 1988
.03 lbs. AI/.25 gal./A (.5 oz AI)	99.6%	McLane, Lab. Reports October 1987 - September 1988
.03 lbs. AI/.125 gal./A (.5 oz. AI)	94%	McLane, Lab. Reports October 1987 - September 1988
.03 lbs. AI/.25 gal./A (.5 oz. AI)	99%	McLane, Lab. Reports October 1988 - September 1989
.03 lbs. AI/.125 gal./A (.5 oz. AI)	100%	McLane, Lab. Reports October 1988 - September 1989
.03 lbs. AI/.25 gal./A (.5 oz. AI)	100%	McLane, Report to Uniroyal
.03 lbs. AI/.125 gal./A (.5 oz. AI)	100%	McLane, Report to Uniroyal

There has also been numerous field tests conducted where lower dosages have been used. A few are mentioned here.

Field (Otis)

Dosage/Rate	Population Reduction	Reference
.015 lbs. AI/gal./A (.25 oz. AI)	98%	McLane, Lab. Report October 1988 - September 1989
.015 lbs. AI/32 oz./A (.25 oz. AI)	99%	McLane, Lab. Report October 1988 - September 1989
.015 lbs. AI/32 oz./A (.25 oz. AI)	100%	McLane, Lab. Reports April - September 1979
.0075 lbs. AI/.5 gal./A* (.125 oz. AI)	100%	McLane, Lab. Reports April - September 1979

*Two applications

During 1990 and 1992 the Commonwealth of Pennsylvania, Department of Environmental Resources conducted work using low dosages of Dimilin. Pennsylvania has used .4 ounces per acre for their suppression programs.

In 1990, they tested .04 and .004 ounces active ingredient per acre at a rate of 128 ounces per acre (Buzzard, Report, January 1991). Foliage protection was achieved with the .04 ounce application but population reduction was such that the treatment area qualified for re-treatment the following year. As a result of this study, Pennsylvania's standard dosage was reduced to .25 ounces for 1991.

In 1991, .125 ounces AI were tested and compared to the new standard of .25 ounces AI per acre. Successful treatment was defined as defoliation below 30 percent and post-spray egg mass counts below 500 per acre (Buzzard, Report, January 1991).

The .125 ounce AI treatment resulted in 86 percent population reduction and good foliage protection but post-spray egg masses (579) qualified the area for re-treatment in 1992.

During the 1992 Pennsylvania gypsy moth suppression project, the efficacy of two reduced dosages of Dimilin 25W (.125 and .187 oz. AI/A) were compared with the standard operational dosage of .25 oz. AI/A.

The .25 and .187 oz. AI/A treatments gave good population reduction at 95 and 92 percent respectively. The .125 oz. AI/A gave 84 percent population reduction.

Extensive laboratory studies at low dosages and the limited field work would certainly indicate that Dimilin can be applied in suppression projects at a much lower dosage than is presently used. If applied properly, there is no reason that Dimilin should not be

applied at .25 oz. AI/acre or lower. All efficacy data indicate that if the material is on the foliage, dosages as low as .01 ounces of active ingredient will work.

There is excellent field data that can support rates of .5 gallons per acre or less if applied properly. Three years of testing by McLane resulted in excellent population reduction when applied at .5 oz. AI in 16 ounces per acre.

Therefore, it would appear that the field efficacy is only as good as the application. If states are willing to enforce the guidelines developed for proper spray techniques, Dimilin can successfully be used at .25 oz. AI/acre or less. Most likely, for suppression projects, application could be made at dosages less than .25 oz. AI/acre. However, if they are not willing to enforce and abide by the rules the dosage should stay at .5 oz. AI/acre.

It is recommended that APHIS, FS and the states cooperate in additional development work with Dimilin at dosages lower than .25 oz. AI/acre and with rates lower than 96 oz./acre.

Mode of Action

Chitin is a colorless mitrogenous polysaccharide chemical compound intermediate between proteins and carbohydrates that is necessary in aiding the gypsy moth moulting process. The loss of chiten will cause the outer skin to develop improperly and rupture from internal pressure causing larval death at moulting time.

Dimilin is a Chitin inhibitor that is absorbed by intake through the stomach and by contact. Therefore, it is important to achieve good spray coverage on the target foliage.

Its contact effect is not fast acting such as that with the synthetic pyrethroids. Mortality will not occur in a mater of hours but will take place in 5 to 7 days, similar to the effects of its being taken through the stomach.

Because of the time period between ingestion and/or contact with Dimilin and actual mortality, some additional defoliation can occur. However, in most cases, its minimal.

Gypsy moth larvae are not apt to fall to the ground immediately after death resulting from Dimilin poisoning. Often they will remain hanging from the leaves until dis-lodged by wind and/or rain.

Late instar gypsy moth larvae and pupae can also be effected by late season applications of Dimilin (see insect size and foliage development).

Application

Dimilin can be applied by fixed wing aircraft, helicopter or ground equipment such as mist blowers or hydraulic sprayers. In some cases, mixing can be done in aircraft, however, it is best to mix in a nurse tank and then transfer the ready mix to the spray aircraft. Proper safety equipment should be used when mixing and handling Dimilin (see label). Droplet VMD (volume mean diameter) should be between 150 and 250 microns. Droplets smaller than 100 micron size should not be used so evaporation and off target drift can be minimized.

Swath widths will vary depending on the type and size of aircraft being used (see APHIS assigned swath widths). Small aircraft will normally use a swath of 75 to 100 feet (Cessna Ag-trucks, Bell 47) with larger aircraft using 100 to 300 feet (DC3, Martin 404). Speed of aircraft will range from 60 to 160 mph. The spray is normally applied between 50 and 75 feet over the tops of the target trees. Do not apply at heights greater than 75 feet as excessive evaporation will occur.

It has been standard procedure to apply Dimilin using diaphragm check valve nozzle bodies (Spraying System Company, Ct. 41, Type 4664B) and standard flat spray tips (Spraying Systems Company, Cat. 41, Tee Jet). Proper strainers (50 mesh) should also be used when applying Dimilin (Spraying Systems Company, Ct. 41, No. 6051-SS). There should be an in-line strainer on the nurse tank and aircraft as well as one for each nozzle. Dirt will normally occur on strainers near the end of the spray boom first. Loss of system pressure often means the main in-line strainer is clogged.

Dimilin has been applied through Micronair rotary atomizers (Maryland) and through a Micromist 900 system (Jeff DuFlo, Spray-Chemical Inc., 1991 in New York).

Although the results of these applications were generally good, one should be very concerned about using these types of equipment to apply Dimilin. The applications of Dimilin are made with mainly water and a very small percentage of active ingredient, therefore, sufficient evaporation can often occur. If rotary atomizers are used, they should be characterized before spraying starts. The atomizers should be adjusted to produce droplets of about 150-250 microns.

Experimental work needs to be conducted with the application of Dimilin 25W and Dimilin 4L using rotary systems. Suppression and eradication application of Dimilin should not be authorized using these types of atomizers until more characterization work is done with each individual system.

For mixing, add powder or flowable to water as it is being agitated and continue to agitate in nurse tank and aircraft until sprayed. If the mix is allowed to sit for 10 minutes without agitation most powder and flowable (Dimilin) will settle to the bottom and require moderate agitation to re-suspend. If allowed to sit over-night, the material will form a hard cake on the bottom of the tank. If this happens very vigorous agitation is required before all the material will go back into suspension. Make sure the aircraft being used has a good agitation system and it is used between the airport and spray plot.

Dimilin 4L is a more desirable formulation to work with and it will stay in suspension more readily than Dimilin 25W.

When properly applied, Dimilin will give 98 to 100 percent population reduction based on pre- and post-egg mass counts.

Insect Size and Foliage Development

It is standard procedure to spray Dimilin when gypsy moth larvae are late 1st and early 2nd instar. At this time, general foliage expansion should be about 25 percent. White oak may only be expanded to 5 percent or less at this time. So in areas where white oak is the dominate species, spray may be applied somewhat later.

If one wishes to apply Dimilin when larvae are late 1st and early 2nd instar, they should check larvae size daily and not go by foliage development.

One major benefit in using Dimilin is its good efficacy against early and late instar larvae (McLane, Lab. Reports, October 1980 - September 1981). If large acreage is sprayed and/or weather conditions are bad, Dimilin can still be effectively applied and efficacious over a much longer period time than *Bacillus thuringiensis*.

Pre-hatch and pre-foliage applications have been tested and found to be very effective (McLane, Lab Report, October 1985 - September 1986, October 1986 - September 1987 and October 1987 - September 1988). It is possible to apply Dimilin at the first sign of hatch or at general hatch and achieve good efficacy. However, this would normally not be done unless excessive acreage was to be sprayed with limited aircraft. One disadvantage of early Dimilin spraying is the fact that more material will land on the ground and possibly contaminate water and ground litter.

Late instars such as 3rd, 4th and 5th instar larvae can be treated resulting in effective population reduction. However, in moderate to heavy populations excessive defoliation may have already occurred when larvae reach this stage.

There is little, if any, additional work that needs to be conducted in this area. If early (pre-foliage) treatments were to become common, it certainly would be advisable to continue environmental impact studies as pertains to contamination of water and forest litter. Most of this work is on-going and is taking place anyway.

Weatherability of Dimilin

The ability of a product to withstand removal from foliage by rainfall becomes very important and sometimes critical to the success of a product in the forestry market. This becomes particularly evident in large operational programs, when the window of application is short or when there are extended periods of inclement weather. Several studies to determine rain fastness of Dimilin 25W and Dimilin 4L have been conducted

on both deciduous and evergreen foliage. Studies done using gypsy moth as an assay organism indicated that essentially complete activity is maintained even after 5 inches of simulated rainfall was applied shortly after Dimilin application. Little data are available to show quantitatively the removal by rain of the spray deposit from deciduous foliage. However, the studies, along with many years of good performance in the field, following rainfall indicates that the weatherability of Dimilin 25W and Dimilin 4L on foliage is excellent.

Oak Seedlings - Greenhouse 1975

Rate - Dimilin 25W 1, 2 and 4 oz. per acre.

Method - Treated seedlings were subjected to 1, 2, 3, 4 and 5 inches of simulated rainfall 1 hours after treatment

Bioassayed using Gypsy Moth, Lymantria dispar

Amount Simulated Rainfall	Mortality at 10 to 13 days		
	Rate 4 oz/gal/A	2 oz/gal/A	1 oz/gal/A
5 inches	98	98	97
4 inches	100	100	100
3 inches	90	82	84
2 inches	95	82	81
1 inch	98	93	99

USDA, APHIS, W. McLane

Oak Seedlings, Greenhouse 1987

Rainfall - simulated

Rate - Dimilin 25W 2 oz. per acre

Method - Treated seedlings were subjected to 0, 1, 2 and 3 inches of simulated rainfall

Bioassayed using Gypsy Moth, Lymantria dispar

Inches Rainfall	% Mortality 7 Days
0	98
1	98
2	100
3	100

USDA, APHIS, W. McLane

Percent mortality of 2nd instar gypsy moth larvae following exposure to oak foliage treated with 3 Dimilin formulations at .0312 lbs. AI/gal./acre.

Formulation	Inches Rain	After 7 Days Mortality
25W	-	98
	1.0	98
	2.0	100
	3.0	100
2F	-	96
	1.0	98
	2.0	99
	3.0	100
4L	-	99
	1.0	100
	2.0	98
	3.0	100
	-	0
Check	3.0	4

USDA, APHIS, W. McLane

Dimilin can be very efficacious when applied to wet foliage (McLane, Lab Reports, October 1988 - September 1989). Often ideal spray time is lost because of wet foliage as a result of rain or dew. Before applying *Bacillus thuringiensis*, dry foliage would be required. Although not recommended as standard practice, Dimilin can be applied to wet foliage if time is a factor.

Percent mortality of 2nd instar larvae following an 8-day exposure to oak seedlings treated with Dimilin on various degrees of wet foliage.

Formulation	Dosage/Rate Acre	Foliage Degree of Wetness	Percent Mortality
Dimilin 25W	.03 lbs./gal.	Dry	100
Dimilin 25W	.03 lbs./gal.	Wet to point of run-off[1/]	100
Dimilin B	.03 lbs./32 oz.	Dry	100
Dimilin B	.03 lbs./32 oz.	Wet to point of run-off[1/]	100
Dimilin C	.03 lbs./16 oz.	Dry	100
Dimilin C	.03 lbs./16 oz.	Wet to point of run-off[1/]	99
Dimilin E	.015 lbs./32 oz.	Dry	100
Dimilin E	.015 lbs./32 oz.	Wet to point of run-off[1/]	100
Control	--	Dry	2

USDA, APHIS, Win McLane
[1/]Seedlings were dripping we at time of Dimilin application.

Most likely, Dimilin could be applied effectively up until minutes before a moderate rainfall. However, to insure a good, effective treatment, a minimum of 2 hours of drying time should be required.

Stability of Dimilin

On a number of occasions, Dimilin nurse tank mixes have been held in the field for up to one week because of bad spray weather. These mixed were mixed vigorously at the end of the holding time and sprayed out onto experimental plots. Results have always been as good as with freshly made batches (McLane). Therefore, it is not necessary to "spike" the mix, to make up for lost potency, or discard the mix. Just make sure everything is in suspension before using.

Dimilin is stable when applied to oak foliage with the half life reported by Uniroyal to be approximately 30 days.

The half life in soil would appear to be much longer. In some cases, gypsy moth larval mortality continued to occur when larvae were exposed to soil surfaces treated with Dimilin 77 days prior to exposure (McLane, Lab. Reports, 1980-1981).

The shelf life of Dimilin 25W and Dimilin 4L appears to be good based on bioassay work by McLane at the USDA, APHIS, Methods Development Center laboratory. Therefore, material that has been in storage for up to 3 years should still be good. Samples can be sent to McLane at the Otis laboratory for efficacy tests.

Cost of Dimilin

The cost of Dimilin 25W is $30 per pound. Dimilin 25W is normally supplied in 5 pound bags, 8 per case.

Dimilin 4L costs $464 per gallon and is supplied in 2.5 gallon containers, 2 per case.

The material is supplied by:

Uniroyal Chemical
Crop Protection Division of
Uniroyal Chemical Company
74 Amity Rd.
Bethany, CT 06525
203-573-2028
203-573-3025

Remaining Studies to be Conducted

1. Continue to evaluate lower dosages and rate of application. This would include the evaluation of anti-evaporant materials.

2. Continue all on-going non-target and environmental studies. Determine where data gaps occur and initiate studies that will fill these gaps.

3. All rotary and conventional spray atomizers need to be characterized with Dimilin (Mission, TX, 1994, NEFAAT).

4. Although one or more drift studies have been conducted with Dimilin, they need to be reviewed to determine if additional work needs to be done.

5. Follow up evaluations of Dimilin treated plots (5 + years) with direct comparison to *Bacillus thuringiensis* spray plots to establish post treatment population trends.

Conclusions

All laboratory and field efficacy studies have determined Dimilin to be extremely efficacious when used against gypsy moth larvae. The material is effective at very low dosages and can be applied to all instars of larval development. Treatments can be applied to early hatch, with little foliage, and the material is very resistant to wash-off from rainfall.

There has never been much question concerning the effectiveness of Dimilin in controlling gypsy moth infestations. The main question has always been its effects on non-targets and the environment in general. Studies, too numerous to mention here, are presently underway to determine Dimilin's fate in the environment. It is important that such studies continue as well as new ones initiated.

Because of these environmental concerns, it is advantageous for Uniroyal and Dimilin users to apply the lowest dosages possible that still give desirable results. Pennsylvania is presently doing this and other states will be required to do the same if they want to continue to use Dimilin. Over the long haul, this will still mean profit for Uniroyal and availability of Dimilin for years to come.

Numerous laboratory and field tests have demonstrated the effectiveness of Dimilin at dosages and rates much lower than what are presently being used. The data support the use of standard suppression treatment dosages of .015 lbs. AI/gal/acre (.25 oz. AI/A). This dosage should be used on suppression projects starting in 1994. In addition, research should start to develop and/or demonstrate effective dosages lower than .25 oz. AI/acre. These efforts should be combined with ones designed to lower the rate of application per acre from one gallon to 64 ounces or less. If we do not do this, Dimilin may be a product of the past, and not available for gypsy moth control in the near future.

Eradication projects should continue to use two applications of Dimilin at .03 lbs. AI/gal/acre (.5 oz. AI/A) until such time that lower dosages have been demonstrated to work consistently over the long haul in suppression projects. If so demonstrated, the dosage for eradication treatments should also be lowered.

With lower dosages and rates of Dimilin being used, it will be very important that the applications be made under suitable spray conditions. This means that supervisors must monitor weather conditions, insect development, foliage development and actual applications more closely. If this is not done, lower dosages will not work consistently. Uniroyal Chemical Company's main concern about using lower dosages and rates is the spraying that takes place under conditions that are not favorable to pesticide application. If state and federal personnel are not willing to enforce the rules, lower dosages will be a failure and Dimilin will be a thing of the past.

One should be very cautious if they plan to use rotary atomizers for application of Dimilin. The formulations being mainly water, small droplets are very susceptible to evaporation. This researcher recommends that rotary atomizers not be used for

application of Dimilin until such time as proper characterization has been done with each spray system.

No stickers or additives are needed when Dimilin is applied in 96 or 128 ounces per acre. However, with rates below 96 ounces per acre, some type of anti-evaporate should be used.

Dimilin drift studies should be revived to determine if suitable data is available to satisfy drift accountability needs that EPA may require in the future. If not, these studies should be conducted.

Applications of DDT, Sevin and Dylox were applied to gypsy moth infestations using 1.0 lbs. AI/acre Dimilin is applied at .5 ounces AI/acre. This material is a very important tool in the arsenal of products we use in controlling the gypsy moth. Hopefully, it will not be lost like other effective compounds we have had in the past.

There are many reports about Dimilin, too numerous to include as part of this brief review. These can be made available if you call Win McLane at 508-563-9303.

Gypsy Moth Suppression Projects by Year

Year	Bt	Dimilin	Sevin	Other**	Acres Treated
1970	0	0	84469	38049	122518
1971	0	0	94310	0	94310
1972	0	0	75229	0	75229
1973	0	0	47443	43484	90927
1974	0	0	69753	104258	174011
1975	0	0	13808	29982	43790
1976	0	0	38634	0	38634
1977	0	0	19633	76513	96146
1978	0	0	34514	135166	169680
1979	0	0	41536	10941	52477
1980	16963	0	18517	44814	80294
1981	22437	0	117085	210598	350120
1982	67324	77918	160242	421246	726730
1983	475898	46500	71468	4794	598660
1984	218324	252769	37040	4072	512205
1985	268975	247322	2192	0	518489
1986	219323	361153	8755	0	589231
1987	318849	375872	3704	0	698425
1988	276050	473430	0	48	749528
1989	413318	384068	0	450	797836
1990	851532	665173	0	2152	1518857
1991	738313	363427	0	1776	1103516
1992	659536	288664	0	12576	960776
1993	375368	206522	0	6343	588233
	4922210	3742818	938332	1147262	10750622

USFS, Daniel Twardus

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A Report to the National Steering Committee for Gypsy Moth and Other Eastern Defoliators

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A Report to the National Steering Committee for Gypsy Moth and Other Eastern Defoliators

Win McLane

USDA, APHIS, PPQ
Otis Methods Development Center
Building 1398
Otis ANGB, MA 02542
508-563-9303
FAX 508-564-4398

A very limited number of materials were screened against gypsy moth larvae in the laboratory. Twelve *Bacillus thuringiensis* samples were screened with some demonstrating good activity against gypsy moth. No materials were tested in the field against gypsy moth larvae. This was do to a lack of suitable materials to test, poor quality of infestations and commitment to other projects such as pine shoot beetle, Japanese beetle and apple ermine moth.

The testing of Golden Natur'l Spray Oil for use on gypsy moth egg masses was completed.

Ten applications were applied to field egg masses in Massachusetts between September 10, 1992 and April 16, 1993. Twenty egg masses were treated with each dosage tested. Treated egg masses were left in the field until late April, when they were removed to the laboratory for hatchability results.

Percent Tested	Hatch
5	Light hatch on 8 of 10 treatments
10	Light hatch on 4 of 10 treatments
15	No hatch
25	Light hatch on 1 of 200 egg masses
50	Light hatch on 1 of 200 egg masses
100	No hatch
Control	Complete hatch on all egg masses

USDA, APHIS, McLane, Cowan and Dubner

Percent hatch of gypsy moth egg masses treated with Golden Natur'l Spray Oil, 1991 - 1992 (McLane, Finney).

Formulation	Treatment Dates					
	1/29/92	2/21/92	3/10/92	3/26/92	4/8/92	4/22/92
100%[a/]	0	0	0	0	0	0
50%[b/]	0	0	0	0	0	0
25%[c/]	0	0	0	0	0	0
5%[d/]	21[e/]	4	7	5	6	3
Control	90[e/]	90	90	90	90	90

[a/] Used undiluted, 100 percent of concentration
[b/] 50 percent of concentrated formulation
[c/] 25 percent of concentrated formulation
[d/] 5 percent of concentrated formulation
[e/] Estimated hatch

As a result of these data, Golden Natur'l Spray Oil was registered for use against gypsy moth egg masses.

Golden Natur'l Spray oil is recommended for application to gypsy moth egg masses to prevent hatch of eggs. Treat egg masses that have been deposited on trees, ground litter, outdoor furniture, recreation vehicles, firewood, nursery stock, rocks, vessels, aircraft and other forms of transportation. Treat egg masses between August and May.

Mixing Directions

Mix equal amounts of Golden Natur'l Spray oil and water and apply to egg masses as a 50 percent mix. Make a new mix each day treatments are made.

Application Technique

With use of a small hand sprayer, treat individual egg masses until they are completely saturated with the spray solution. Keep the mix agitated while treating. General application by mist blower, hydraulic sprayer or aircraft is not recommended. It is important that the egg mass is saturated with the spray. Following treatment, egg masses can be left in place or removed and incinerated.

Do not exceed maximum rate or apply when not recommended.

EPA registration number - 57538-11
EPA establishment number - 34160-TX-1

The material is available from:

Stoller Enterprises, Inc.
8582 Katy Freeway
Houston, TX 77024
713-464-5580

Experimental laboratory work was conducted with a number of candidate stickers to identify one for use with gypsy moth pheromone flakes. The presently used RA 1990 will be phased out of production by Monsanto.

Laboratory results indicated a suitable replacement would be Gelva 2333 or Gelva 2484 made by Monsanto. They have assured us that the Gelva 2333 would be available for the future and they feel it would be a better product than Gelva 2484.

Experimental laboratory work was conducted with Shin Etsu gypsy moth pheromone chips. Initial work demonstrated its ability to stick on oak foliage when used with a sticker furnished by Shin Etsu.

The release rate of Shin Etsu chips appears to be similar to that of AgriSense beads (Leonhardt).

Hercon flakes, AgriSense beads and Shin Etsu chips were tested in Virginia. Flakes and beads were applied by aircraft to isolated experimental plots with low gypsy moth populations. Results are not available at this time. Chips were tested by ground equipment and aircraft, mainly to determine their sprayability and pheromone release rate. The chip formulation was sprayed by aircraft through CP spray nozzles with no problems. The formulation needs to be adjusted with a thickener to better keep the chips in suspension.

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Experiments [illegible] were conducted [illegible] to identify one for use with gypsy moth pheromone flakes. The presently used RA 1061 will be phased out of production by Monsanto.

[illegible] tested a possible replacement [illegible] made by Monsanto. They have [illegible] the future and feel it would be a better product.

Experimental laboratory work was [illegible] with Shin Etsu [illegible] chips. It demonstrated its ability to stick on oak foliage when used in a sticker [illegible]

The release rate of Shin Etsu chips appears to be similar to that of [illegible] flakes (Leonhardt).

[illegible] Shin Etsu chips were [illegible]

[illegible] are not available at this time. Chips were tested [illegible] aircraft, mainly to determine [illegible] and pheromone release rate. The chip formulation was [illegible] problems. The formulation needs to be adjusted [illegible] chips [illegible]

1978 and 1979 Small Plot Field Studies Using
Dimilin, Sevin, Thuricide and SIR 8514
April 1, 1979 - September 30, 1979

Project Number: GM 8.1.2
Project Title: 1978 and 1979 Small Plot Field Studies Using Dimilin, Sevin, Thuricide and SIR 8514
Report Period: April 1, 1979 - September 30, 1979
Report Type: Interim
Project Leaders: Winfred H. McLane, R. G. Reeves, J. A. Finney

Because of a heavy work load during the preparation of our last report (October, 1978 - March 1979) no report was submitted. All work for the past year will be covered in this report.

Introduction:

Once candidate insecticides have proven to be efficacious in the laboratory the more effective ones are tested on small plots under field conditions. New formulations and lower rates and dosages of registered are also tested on small field plots before going operational.

The objectives of the work reported for 1978 were; test Dimilin at lower dosages and rates of application to establish firm treatment recommendations for future regulatory and isolated infestation applications, test Dimilin 25W in an oil formulation to see how it compares to the water formulation and use Sevin 4-oil as a standard.

Materials and Methods 1978:

Aerial application tests were conducted with Dimilin and Sevin 4-oil on 30 plots, 50 acres each in size. Specific treatments evaluated are listed in Table 1.

Table 1. Summary of 1978 tests with Dimilin and Sevin 4-oil.

Material	Dosage/Rate	No. Applications	No. Plots
Dimilin 25W	0.0075 lb AI/0.5 gal/A	2	3
" "	0.015 lb AI/0.5 gal/A	2	3
" "	0.015 lb AI/0.25 gal/A	2	3
" "	0.010 lb AI/0.25 gal/A	1	6
" "	0.03 lb AI/0.25 gal/A	1	6
Dimilin 25W w/oil	0.03 lb AI/0.25 gal/A	1	6
Sevin 4-oil	1.0 lb AI/40 oz/A	1	3
Checks	-	-	6

Test plots were established in Clinton County, Pennsylvania. The population was determined to range from 273 to 4,160 egg masses per acre. Each 50 acre plot was laid out by establishing an accessible base corner and plotting boundary lines along compass headings. Markers were placed at all four corners for aircraft guidance. Within each plot, 20 prism points were established for sampling, pre- and post-spray. Sampling points were located on four parallel lines within the center 10 acres of each plot. Sampling points were similarly established in untreated check areas. All applications were made when the majority of insects were in the second instar and oak foliage was 50-75 percent expanded.

Materials were mixed and transferred into the aircraft with conventional equipment (mixing tank, pumps, hoses, measuring devices and necessary safety equipment). Mixing and spray equipment was thoroughly cleaned between each treatment to avoid adulteration.

Treatments were made with a Cessna Ag Truck aircraft equipped with a hydraulic driven impeller pump and a conventional spray system. The aircraft dispersed the material in 60 foot swaths at 120 mph approximately 30 feet above tree tops. In plots receiving double application, treatments were made 7 days apart. Details of the formulation and application parameters are summarized in Table 2.

Table 2. Application Data for 1978 Aerial Application.

Dosage	Formulation	Nozzle Type	No. Nozzles	Air Speed	Swath Width	Size Droplet	Temp.
0.0075 lb AI/0.5 g/A	Dimilin 25W	8004 flat fan	18	120 mph	60'	150 - 300μ	80°F
0.015 lb AI/0.5 g/A	Dimilin 25W	8004 flat fan	18	120 mph	60'	150 - 300μ	80°F
0.015 lb AI/0.25 g/A	Dimilin 25W	8002 flat fan	18	120 mph	60'	150 - 250μ	85°F
0.01 lb AI/0.25 g/A	Dimilin 25W	8002 flat fan	18	120 mph	60'	150 - 250μ	80°F
0.03 lb AI/0.25 g/A	Dimilin 25W	8002 flat fan	18	120 mph	60'	150 - 250μ	85°F
0.03 lb AI/0.25 g/A	Dimilin 25W with 50% H_2O + 50% Savol oil	8002 flat fan	15	120 mph	60'	100 - 225μ	75°F
1.0 lb AI/40 oz/A	Sevin 4-oil	8003 flat fan	15	120 mph	60'	150 - 250μ	55°F

Nozzles were pointed 90° to slip stream in all treatments.

In plots receiving two applications of Dimilin, 10 oak trees at each prism point were banded with burlap. Larval counts were conducted under burlaps three times following treatment.

Table 3. Average number of larvae counted under burlap bands in plots treated with 2 applications of Dimilin. Average of 200 burlaps in each of 3 plots.

Plot No.	Dosage	Number of Live Larvae 15 days 1/	20 days	25 days
1 - 3	0.015 lb AI/0.5 g/A	28.8	2.5	0
4 - 6	0.015 lb AI/qt/A	31.6	.2	0
19, 21, 24	0.0075 lb AI/0.5 g/A	.7	.3	0
27 - 28	Check	79.5	108.5	.75 2/

1/ Number of days following second treatment.

2/ Decline mainly due to virus mortality in late instar larvae.

It was originally planned to make a defoliation survey in each plot, however, defoliation was light and not distinguishable between pre and post treatments. Therefore, defoliation estimates were not made. However, egg mass counts were conducted at each prism point location in all treatment and control plots. Those results are summarized in Table 4.

Table 4. Pre- and post-spray egg mass counts in Dimilin and Sevin spray plots, 1978.

Plots	Material	Dosage	Pre-Spray	Post-Spray	Percent Reduction
1-2-3	Dimilin 1/	0.015 lb AI/0.5 g/A	1509 2/	0.66	99.06
4-5-6	Dimilin	0.015 lb AI/qt/A	851	0	100
19-21-24	Dimilin	0.0075 lb AI/0.5 g/A	796	0	100
7-8-10 11-12-13	Dimilin + Oil	0.03 lb AI/qt/A	722	0	100
31-32-33 34-35-36	Dimilin	0.03 lb AI/qt/A	961	0.1	99.09
37-38-39 42-43-44	Dimilin	0.01 lb AI/qt/A	754	1	99.97
15-16-20	Sevin 4-Oil + Kerosene	1.0 lb AI/40 oz/A	799	1.33	99.94
14-23-27 28-40-41	Check	-	406	13	96.8

1/ Unless otherwise stated all Dimilin was mixed in water.

2/ Egg masses/acre.

Conclusions:

A general population collapse occurred in all study plots. Heavy virus mortality occurred in all plots when larvae were in the late instars. Therefore, it is not possible to base the effectiveness of various Dimilin Sevin 4-oil treatment on pre- and post-spray egg mass counts. Although post spray egg mass counts were somewhat higher in check plots, no significant differences occurred.

Because heavy virus mortality occurred during the late instars, all evaluations will be based on the first two larval counts. It is, therefore, impossible to evaluate treatment plots where burlaps were not used. However, general observations indicated that efficacy was similar when .03 lb Dimilin was formulated in water or Savol oil applied at 1 qt/A. Dimilin also performed well when applied at 0.01 lb/A in 1 qt. water.

Based on larval counts we can conclude that Dimilin gave some degree of control when applied in two applications of 0.5 gal. each at 0.0075 lb AI/A. Similar results were obtained when 0.015 lb Dimilin was applied in double applications of 1 pt or 2 qt. Based on larval counts above, we are unable to recommend the use of 0.0075 or 0.015 lb of Dimilin per acre.

1979 Field Tests:

With the use of chemical pesticides becoming increasingly restricted, it is important that acceptable alternative materials be developed. Agents such as *Bacillus thuringiensis* (Bt) have been registered for gypsy moth control for a number of years but have rarely been used, mainly because of inconsistent results rendered.

During 1979, fifteen 50 acre plots were treated with Thuricide 16B and Thuricide 24B. An early treatment with Dimilin was made on three 50 acre plots and SIR 8514, an experimental growth regulator was also tested on 3 plots.

Materials and Methods 1979:

The test materials were supplied by Sandoz, Inc. and Mobay Chemical Company. Thuricide was delivered to the mixing site in 55 gallon drums. SIR 8514, an experimental growth regulator from Mobay was delivered as a wettable powder. Details of the experimental program are summarized in Table 1.

Table 1. Summary of 1979 field tests with Thuricide, Dimilin and SIR 8514.

Material	Dosage	No. Appl.	Date	Plot No.	Pre spray egg masses/A
Dimilin 25W	0.03 lb AI/A 1/	1	5/3	1-3	143
Thuricide 16B	8 BIU/A 2/	2	5/15-5/31	15-17	63
Thuricide 16B	8 BIU/A 3/	2	5/15-5/31	12,22,23	27
Thuricide 24B	8 BIU/A 3/	2	5/17-5/31	8,20,21	80
Thuricide 24B Not Centrifuged	8 BIU/A 3/	2	5/18-5/30	7,9,13	33
Thuricide 16B	8 BIU/A 3/	1 4/	5/27	10,11,19	23
SIR 8514	0.03 lb AI/A 2/	1	5/20	4-6	173
Checks	-	-	-	14,18 24,27	68

1/ Treatment made when 50 percent of egg masses had hatched out.

2/ Applied in 0.5 gal/A.

3/ Applied in 0.75 gal/A.

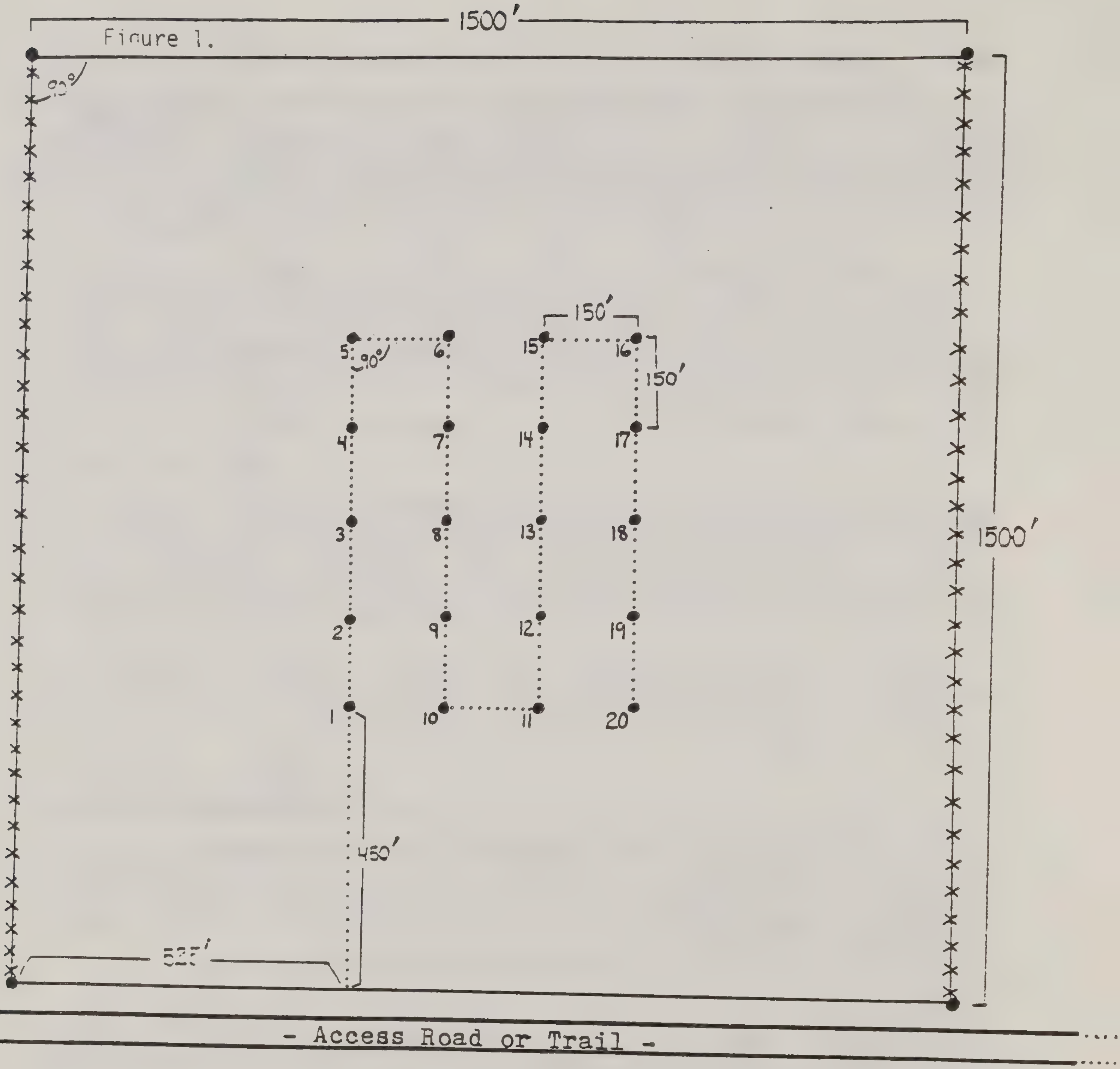
4/ Application was to be two applications on 4th instar larvae.

Test plots were established near W. Milford, NJ in Passaic County. All spray plots and checks were located within bounds of the "Newark Watershed Conservation and Development Corporation". This met with the approval of the Watershed Commission and the City of Newark.

All spray plots were 50 acres in size and adjacent plots were separated by at least 500 feet. Within the central 10 acres of each plot, a rectangular grid of 20 equidistant prism points was constructed for the purpose of egg mass, larval and pupal sampling procedures. At time of treatment each corner of the spray plot was marked for navigational assistance by a helium filled yellow balloon.

Figure 1. Standard 50 square acre spray plot layout.

Figure 1.



× - Single Orange Ribbon Flags at 25' Intervals

• - Plot Corner (identified with double orange ribbon flag and luggage tag labeled NE, SE, NW or SW.)

⋮ - Single Pink Ribbon Flags at 25' Intervals

● - Prism Point (identified with double pink ribbon flag and luggage tag labeled with point number.)

Application:

Mixing and aircraft operations were conducted out of Greenwood Lake Airport, West Milford, NJ. The application schedule was designed so that the first application of Thuricide and the one application of SIR 8514 would be applied when the majority of larvae were in the second instar. The second application of Thuricide was to be made 10 days following the first. Because of weather and aircraft scheduling, our second application of Thuricide was not applied until 12-18 days following the first treatment.

The early Dimilin application was scheduled to determine the effects of a treatment when egg masses were 50 percent hatched and no foliage present. Tests during 1974 indicated that Dimilin could be effective against gypsy moth larvae when sprayed prior to foliage development.

Materials were mixed and transferred into the aircraft with conventional equipment (mixing tank, pumps, hoses, measuring devices and necessary safety equipment). All mixing and spraying equipment was thoroughly cleaned between each treatment to avoid adulteration.

All spray plots were treated with a Cessna Ag Truck aircraft except for the second application of Thuricide. Due to aircraft scheduling, a helicopter was contracted to make the second application of Thuricide. Application data are summarized in Table 2.

Table 2. Application data for 1979 aerial treatments.

Material	Dosage	Nozzle	No. Nozzle	Air Speed	Swath Width	Temp.
SIR 8514	0.03 lb AI/A 1/	8004	18	120	60'	90°F
Dimilin	0.03 lb AI/A 1/	8004	18	120	60'	60°F
Thuricide 16B	8 BIU/A 1/	8004	24	120	60'	90°F
	"	8004	8	30	80'	80°F
Thuricide 16B	8 BIU/A 2/	8006	18	120	60'	90°F
	"	8006	8	50	80'	79°F
Thuricide 24B	8 BIU/A 2/	8006	18	120	60'	67°F
Centrifuged	"	8004	8	50	80'	76°F
Thuricide 24B	8 BIU/A 2/	8006	18	120	60'	50°F
Not centrifuged	"	8004	8	50	80'	76°F
Thuricide 16B	8 BIU/A 2/ (4th instar)	8006	18	120	60'	44°F

1/ Applied in 0.5 gal.

2/ Applied in 0.75 gal.

At each prism point a total of 10 oak trees were banded with burlap bands to evaluate larval mortality. Results are summarized in Table 3.

Table 3. Larval counts in treated and check plots.

Material	Dosage	Days after Treatment	No. Larvae 1/
SIR 8514	0.03 lb AI/A 2/	33	862
Dimilin	0.03 lb AI/A 2/	42	2,455
Thuricide 16B	8 BIU/A 3/	26	2,180
Thuricide 16B	8 BIU/A 2/	34	1,072
Thuricide 24B centrifuged	8 BIU/A 3/	20	2,581
Thuricide 24B not centrifuged	8 BIU/A 3/	28	2,413
Thuricide 16B	8 BIU/A 3/ 4/	33	1,126
Checks	-	-	3,908

1/ Average of 3 plots each treatment and 200 burlaps per plot, 10 at each prism point. Control average of 6 plots.

2/ Applied in 0.5 gal.

3/ Applied in 0.75 gal.

4/ Three plots received one application against 3rd and 4th instar larvae.

Conclusions:

Although final evaluation of the effectiveness of each treatment will be determined from fall egg mass counts, large numbers of healthy larvae under burlap bands 4 to 5 weeks following treatment is not a good sign. Based on the number of larvae present in the Dimilin plots following treatment, we would have to say that this treatment was not effective. In the SIR 8514 plots there was more larval activity than expected following treatment.

A final report will be published in the October 1, 1979 - March 31, 1980 laboratory report.

[illegible]

1/ [illegible]
2/ [illegible]
3/ [illegible]

[illegible]

plots therefore were [illegible]

A final report will be published [illegible] October [illegible] Tabular report.

[illegible]

Table [illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
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Laboratory Screening of Candidate Pesticides
Against the Gypsy Moth
April 1, 1977 - September 30, 1977

M

Project Number: GM 7.1.1
Project Title: Laboratory Screening of Candidate Pesticides Against the Gypsy Moth
Report Period: April 1, 1977 - September 30, 1977
Report Type: Interim
Project Leaders: Winfred H. McLane, J. A. Finney

The primary objective of this laboratory screening project is to collect mortality data on registered and experimental compounds potentially useful against the gypsy moth, evaluating this data and selecting suitable materials for field testing. All of the tests herein reported were conducted by standard techniques with oak seedlings and 2nd instar larvae.

Two new growth regulators (Bay Sir 6874 and 8514) were compared with Dimilin 25 WP.

Material	Company	Dosage 1/	Weather	% Mortality	Days After Treatment
Bay Sir 6874	Chemagro	0.25		97	9
Dimilin 25 W	Thompson-Hayward	0.25		92	9
Bay Sir 6874		0.125		97	9
Dimilin 25 W		0.125		97	9
Bay Sir 6874		0.06		100	9
Dimilin 25 W		0.06		100	9
Bay Sir 6874		0.03		100	9
Dimilin 25 W		0.03		100	9
Bay Sir 6874		0.015		100	9
Dimilin 25 W		0.015		100	9
Bay Sir 6874		0.0078		86	9
Dimilin 25 W		0.0078		88	9
Bay Sir 6874		0.0039		89	9
Dimilin 25 W		0.0039		91	9
Check		No Treatment		0	9

When Bay Sir 6874 was mixed with crop oil supplied by Chemagro, treated plants showed signs of phytotoxicity. This was mostly observed when applications of a gallon per acre were applied.

Material	Company	Dosage	Weather	% Mortality	Days After Treatment
Bay Sir 8514-25W	Chemagro	0.25		100	9
Dimilin 25 W	Thompson-Hayward	0.25		99	9
Bay Sir 8514-25W		0.125		98	9
Dimilin 25 W		0.125		98	9
Bay Sir 8514-25W		0.06		97	9
Dimilin 25 W		0.06		99	9
Bay Sir 8514-25W		0.03		100	13
Dimilin 25 W		0.03		100	13
Bay Sir 8514-25W		0.015		100	13
Dimilin 25 W		0.015		100	13
Bay Sir 8514-25W		0.0078		100	13
Dimilin 25 W		0.0078		100	13
Bay Sir 8514-25W		0.0039		100	12
Dimilin 25 W		0.0039		98	12
Bay Sir 8514-25W		0.0019		98	12
Dimilin 25 W		0.0019		100	12
Bay Sir 8514-25W		0.0009		95	12
Dimilin 25 W		0.0009		100	12
Bay Sir 8514-25W		0.0004		52	11
Dimilin 25 W		0.0004		55	11
Bay Sir 8514-25W		0.0002		32	11
Dimilin 25 W		0.0002		64	11
Bay Sir 8514-25W		0.0001		22	11
Dimilin 25 W		0.0001		18	11
Check		No Treatment		0	13
Bay Sir 8514-EC	Chemagro	0.25		96	12
Dimilin 25 W	Thompson-Hayward	0.25		98	12
Bay Sir 8514-EC		0.12		100	12
Dimilin 25 W		0.12		98	12
Bay Sir 8514-EC		0.06		98	12
Dimilin 25 W		0.06		97	12
Check		No Treatment		0	12

Material	Company	Dosage	Weather	% Mortality	Days After Treatment
Bay Sir 8514-TECH	Chemagro	0.25		100	14
Dimilin 25 W	Thompson-Hayward	0.25		95	14
Bay Sir 8514-TECH		0.12		100	14
Dimilin 25 W		0.12		94	14
Bay Sir 8514-TECH		0.06		100	14
Dimilin 25 W		0.06		99	14
Bay Sir 8514-TECH		0.03		100	13
Dimilin 25 W		0.03		94	13
Bay Sir 8514-TECH		0.015		100	13
Dimilin 25 W		0.015		99	13
Bay Sir 8514-TECH		0.0078		100	13
Dimilin 25 W		0.0078		99	13
Check		No Treatment		0	14

Material	Company	Dosage 2/	Weather	% Mortality	Days After Treatment
Bay Sir 8514-TECH	Chemagro	0.06		93	9
Bay Sir 8514-TECH		0.03		89	9
Bay Sir 8514-TECH		0.015		91	9
Bay Sir 8514-TECH		0.0078		85	9
Bay Sir 8514-TECH		0.0039		92	9
Bay Sir 8514-TECH		0.0019		93	9
Check		No Treatment		0	9

Material	Company	Dosage 1/	Weather	% Mortality	Days After Treatment
Bay Sir 8514-25W	Chemagro	0.06	1"	100	13
Dimilin 25 W	Thompson-Hayward	0.06	1"	94	13
Bay Sir 8514-25W		0.03	1"	93	13
Dimilin 25 W		0.03	1"	99	13
Bay Sir 8514-25W		0.015	1"	100	13
Dimilin 25 W		0.015	1"	97	13
Check		No Treatment	1"	0	13

Material	Company	Dosage 1/	Weather	% Mortality	Days After Treatment
Bay Sir 8514-25W	Chemagro	0.06	3"	98	10
Dimilin 25 W	Thompson-Hayward	0.06	3"	96	10
Bay Sir 8514-25W		0.03	3"	100	10
Dimilin 25 W		0.03	3"	100	10
Bay Sir 8514-25W		0.015	3"	95	10
Dimilin 25 W		0.015	3"	94	10
Check		No Treatment	3"	0	10
Dimilin 25 W	Thompson-Hayward	0.06		95	15
Dimilin-OD		0.06		98	15
Dimilin 25 W		0.03		99	15
Dimilin-OD		0.03		98	15
Dimilin 25 W		0.015		100	15
Dimilin-OD		0.015		96	15
Dimilin 25 W		0.0078		100	15
Dimilin-OD		0.0078		91	15
Dimilin 25 W		0.0039		100	15
Dimilin-OD		0.0039		88	15
Check		No Treatment		0	15
FMC-47628-TECH	FMC	0.025		97	8
FMC-47628-TECH		0.125		88	8
FMC-47628-TECH		0.062		71	8
FMC-47628-TECH		0.031		10	8
FMC-47628-TECH		0.015		1	8
Check		No Treatment		0	8
FMC-50215-TECH	FMC	1.0		100	7
FMC-50215-TECH		0.5		100	7
FMC-50215-TECH		0.25		100	7
FMC-50215-TECH		0.125		100	7
FMC-50215-TECH		0.062		92	7
FMC-50215-TECH		0.031		48	6
FMC-50215-TECH		0.015		10	6
FMC-50215-TECH		0.007		0	6
Check		No Treatment		0	7

1989 Field Studies with Low Volume Applications of Dimilin 2F (Speical) Against the Gypsy Moth (Lymantria dispar L.)
October 1, 1988 - September 30, 1989

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Project Number: GM 89.1.1.B
Project Title: 1989 Field Studies with Low Volume Applications of Dimilin 2F (Special) Against the Gypsy Moth (*Lymantria dispar* L.)
Report Period: October 1, 1988 - September 30, 1989
Report Type: Final
Project Leaders: W. McLane and J. Finney

Introduction

In 1990 approximately half of the total acreage (>1,000,000 acres) sprayed for gypsy moth control in the United States will be treated with Dimilin 25W. Nearly all Dimilin treatments will be applied at .03 lbs. AI/gallon/acre. The remaining acreage will be treated with various formulations of *Bacillus thuringiensis*. Most *Bt* is applied at one gallon per acre. However, a number of studies have demonstrated that the material can be applied successfully undiluted at 32 to 64 ounces per acre.

Undiluted ultra low volume (ULV) applications can save money and time. Much less ferrying time is needed and each load can cover more acres under more ideal spray conditions. No need for mixing equipment and crew is an additional savings.

In 1988 Dimilin 2F (Special) was tested at ultra low volume in Pennsylvania on 50-acre plots (McLane, Finney, Roland, Yendol and Bohne). The ultra low volume treatments were compared to a standard of Dimilin 25W at .03 lbs. AI/gallon/acre. Dr. Yendol and staff at Pennsylvania State University conducted a residue study in two of the treatment areas using fluorometer determinations.

Population reduction was superior in (ULV) applications of 64 and 32 ounces per acre to that of the standard Dimilin 25W at a gallon per acre. An application of 16 ounces per acre was equal to the standard. Dr. Yendol found nearly twice as much residue in the quart per acre treatment as in the standard Dimilin 25W at a gallon per acre (Yendol, McLane, Roland and Reardon).

Table 1. Percent population change based on pre- and post-spray egg mass counts.

Treatment	Pre-spray EM/acre	Post-spray EM/acre	Percent change
128 oz.	1,110	50	- 95.4
64 oz.	1,101	10	- 99.0
32 oz.	1,193	4	- 99.6
16 oz.	1,103	66	- 94
Control	894	5,459	+510.6

Table 2. An estimate of the Dimilin spray (micrograms/cm^2 AI) found on oak foliage when aerially applied at 128 and 32 fl. oz. per acre.

Rate	N	Tree section	Microgram/cm^2 Mean(a)	Log 10 Mean(b)	Error
128 fl. oz./A	500	both	0.00912	-2.04	0.04
	250	lower	0.00676	-2.17	0.06
	250	upper	0.01202	-1.92	0.05
32 fl. oz./A	500	both	0.01413	-1.85	0.04
	250	lower	0.01148	-1.94	0.07
	250	upper	0.01698	-1.77	0.07

(a) Calculated using the geometric mean method.
(b) Transformed from Log10 mean value.

Numerous laboratory and limited field studies indicate that Dimilin can be successfully applied at dosages lower than those presently used (McLane & Finney, and Herbaugh, McLane & Finney). With increasing concerns of the general public about the use of all pesticides, it is important that we use the smallest effective amount possible. Dimilin 25W is presently used at .03 lbs. AI/gallon/acre.

During 1989 field studies continued with (ULV) applications of Dimilin 2F (Special) as well as lower dosages of each formulation.

Table 3. Treatments for 1989 Dimilin (ULV) and low dosage studies.

Formulation	Dosage/rate	Acres treated
Dimilin 25W	.03 lbs.AI/128oz/acre	200
Dimilin 25W	.015lbs.AI/128oz/acre	200
Dimilin 2F (SP)	.03 lbs.AI/32oz/acre	200
Dimilin 2F (SP)	.015lbs.AI/32oz/acre	200
Dimilin 2F (SP)	.03 lbs.AI/16oz/acre	200
Dimilin 4F	.03 lbs.AI/128oz/acre	400
Control	--	200

Approximately 400 acres were also treated with a Dimilin 4F (flowable) formulation.

Methods and Techniques

Twenty-four woodland plots were established on state game lands in Elk and Jefferson Counties, Pennsylvania. Plots were square and 50 acres in size and located a minimum of 400 feet apart. Boundary lines were surveyed and marked with fluorescent orange tape and each corner tree was marked with double

fluorescent orange tape and a tag identifying corners and plot numbers. Plots were located so that there would be a maximum number of corners on or near roadways.

Treatment evaluation consisted of pre- and post-spray egg mass counts, egg hatchability tests, post-spray larvae counts under burlap, defoliation observations and residue work using wash-off and HPLC techniques.

Within the center 10 acres of each plot, 10 prism points were established, 5 points on 2 parallel lines. During March and early April, pre-spray egg mass numbers were recorded on each prism tree and within each fixed radius plot. Prism tree DBH was also recorded. A limited number of egg masses were collected from the field and returned to the laboratory for hatchability tests. Hatch was uniform at 80> percent with little virus load.

Burlap was placed on 5 oak trees at random in the center 10 acres of one plot in each treatment. Three counts were made on the number of gypsy moth larvae under each band following treatment. After each reading, all larvae were removed from under the burlaps.

At peak defoliation time (early July), a survey was conducted from the ground. Total defoliation of all oak species was estimated at each prism point within each experimental plot.

Within 4 hours of treatment, foliage was collected in one plot each of the 128, 32 and 16 ounce treatments. Foliage was collected from the top, mid- and lower crown of 10 trees within each plot. From each tree and each location within the crown, foliage was collected at each cardinal direction.

Ten leaves were selected for HPLC work and 10 for wash-off (fluorometric determinations) work at Pennsylvania State University.

All foliage was shot out of the trees using a 12-gauge shotgun with 2.75 and 3 inch shells. This technique worked very well except for some black and blue shoulders.

Foliage was shipped to the USDA, APHIS National Monitoring Laboratory at Gulfport, Mississippi for HPLC analysis. Ms. J. Finney, assisted by Dr. Yendol's staff at Pennsylvania State University, did the wash-off (fluorometric determinations) analysis.

An APHIS Cessna Ag-truck aircraft was used to apply all treatments. Applications of 128 ounces per acre were made with 8004 flat fan nozzle tips with lesser amounts applied through 8002 nozzle tips. The aircraft sprayed a 75-foot swath at 120 mph, approximately 50 feet above the target foliage. Boom pressure was 40 psi. Screens of 50 mesh size were used in each nozzle and in the nurse tank.

The aircraft was calibrated over the first spray plot. Mixing was done in a nurse tank and then material was pumped into the aircraft. Additions to the Dimilin 2F (Special) formulation were added as a tank mix at the base of operations, DuBois Airport. A boom timer was used to aid calibration.

All applications were made in the morning hours between 6:00-12:00 AM starting 6/1 and ending 6/3. Temperatures ranged between 50° - 75°F. Application was terminated when winds exceeded 6 mph or temperatures reached 80°F or humidity dropped below 45%.

At time of treatment, the majority of larvae were mid to late 2nd instar. In general, foliage was expanded 40-60 percent.

Results

All treatments gave excellent gypsy moth population reduction based on egg mass counts. The (ULV) and low dosage treatments were as effective as the standard of Dimilin 25W. However, it was unfortunate that a population reduction also occurred in the untreated controls and therefore treatment and control comparisons are compromised.

We had problems mixing the emulsifiers and additives with the Dimilin 2F (Special) formulation in the field. Although we did use a considerable amount of emulsifier, the mix was not good. The formulation needs to be worked on to correct this problem.

Once the material was in the aircraft, it dispersed well and caused no blockage of nozzles or screens.

A significant amount of rainfall occurred during the 3-day period following treatments. However, this should have had no effect on the efficacy based on laboratory tests (McLane and Finney).

Foliage protection was excellent in all treatments and larvae numbers under burlap were greatly reduced in all treatment plots.

As was the case in our 1988 study (Yendol, McLane, Roland and Reardon), the HPLC analysis recovered nearly as much Dimilin 2F (Special) in the 32 ounce/acre treatment as Dimilin 25W in the 128 ounce/acre application. This again demonstrates the excessive evaporation taking place with the Dimilin 25W formulation. The Dimilin 2F (Special) at 16 ounces/acre had less material on foliage than the Dimilin 25W treatment at 128 ounces per acre.

Most Dimilin 25W was found high up in the tree (twice that found in the mid- or lower crown), whereas the Dimilin 2F (Special) at 16 and 32 ounces was very uniform in its deposit from top to lower crown. This was likely due to the finer droplets produced by the 8002 flat fan tips being able to penetrate the foliage canopy more efficiently. Most larger droplets produced by the 8004 flat fan tips stayed near the top of the tree crown.

The wash-off tests (fluorometer determinations) conducted at Pennsylvania State University also identify most of the Dimilin 25W at 128 ounces per acre as being high up in the tree and the Dimilin 2F (Special) as being more uniform throughout the tree.

Based on 1988 and this year's data, it is evident that (ULV) applications of Dimilin 2F (Special) can be just as effective as the standard formulation now being used at 128 ounces per acre. It is therefore time to conduct a pilot test with Dimilin 2F (Special) so that operational programs can use it in the near future. However, before this can happen, the formulation has to be improved so that mixing does not have to take place in the field. If this requires registration, it must be addressed as soon as possible.

The Dimilin 4F formulation performed very well based on efficacy, mixing and handling. This is a formulation that should be registered for use as the Dimilin 25W is presently used. It could also be used as a Special for (ULV) applications.

Again, as in 1975, low dosages were very effective. It is important that this work continue so that lower dosages can someday be used to ease the environmental concerns. If lower dosages are not available for use in the future, we may not have Dimilin to use at all.

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Table 4. Percent population change based on pre- and post-spray egg mass counts.

Formulation	Dosage/rate lbs.AI/oz/acre	Pre-spray[1/] Egg masses/acre	Post-spray[1/] Egg masses/acre	Percent change
Dimilin 25W	.03/128oz	635	14	- 97.7
Dimilin 25W	.015/128oz	544	12	- 97.8
Dimilin 2F(SP)	.03/32oz	801	3	- 99.1
Dimilin 2F(SP)	.015/32oz	1902	0	-100
Dimilin 2F(SP)	.03/16oz	705	1	- 99.8
Dimilin 4F	.03/128oz	946	11	- 98.8
Control		536[2/]	369[2/]	- 31.1

1/ Average of 4 spray plots
2/ Average of 5 untreated plots

Table 5. Average number of larvae under burlaps after spraying and percent defoliation at peak defoliation time.

Formulation	Dosage/rate lbs.AI/oz/acre	Larvae under burlap	Percent defoliation
Dimilin 25W	.03/128oz	1.5	0-10
Dimilin 25W	.015/128oz	0	0-10
Dimilin 2F(SP)	.03/32oz	.33	0-10
Dimilin 2F(SP)	.015/32oz	0	0-10
Dimilin 2F(SP)	.03/16oz	.66	0-10
Dimilin 4F	.03/128oz	--	0-10
Control	--	6.88	20-30

Table 6. Rainfall during and after application time.

Date	Inches rain
6/1	0.48
6/2	0.0
6/3	0.22
6/4	0.33
6/5	0.46
6/6	0.05
6/7	0.39
6/8	0.01
6/9	0.07
6/10	0.07

Table 7. Average ppm of Dimilin recovered from 10 trees at various canopy locations using HPLC.

Formulation	Dosage/rate lbs.AI/oz/acre	High	Medium	Low	Average 3 locations
Dimilin 25W	.03/128oz	2.047	1.092	0.931	1.356
Dimilin 2F (SP)	.03/32oz	2.3	2.01	1.829	2.046
Dimilin 2F (SP)	.03/16oz	.846	.838	1.045	.909
Control	--	<.5	<.5	<.5	<.5

Table 8. Average fluorescence of dye recovered from 10 trees at various canopy locations.

Formulation	Dosage/rate lbs.AI/oz/acre	High	Medium	Low	Average 3 locations
Dimilin 25W	.03/128oz	364	332	248	315
Dimilin 2F(SP)	.03/32oz	378	424	428	410
Dimilin 2F(SP)	.03/16oz	253	285	307	282
Control	--	91	113	110	105

Title: Determination of Dimilin® Residues in Vegetation Samples
Analyst: R. Reeves
Contributors: D. Ladner

Introduction

One hundred twenty (120) vegetation samples (pre-treatments and post-treatments) for the Gypsy Moth Program were received from the Otis Methods Development Center by the National Monitoring and Residue Analysis Laboratory in Gulfport, Mississippi, for analyses. The samples were analyzed for Dimilin® content.

Objective

To analyze vegetation samples for Dimilin® residues. These analyses were accomplished by high performance liquid chromatography (HPLC). Selected samples were confirmed by gas chromatography/mass spectrometry (GC/MS).

Methodology

NMRAL analyzed the vegetation samples in accordance with Processing Procedure PR0096, "Analysis of Diflubenzuron (Dimilin®) in Vegetation by Reversed Phase Higher Performance Liquid Chromatography", October 26, 1989.

Analyses for Dimilin® were accomplished on a Hewlett-Packard (HP) 1084B High Performance Liquid Chromatography using Beckman System Gold Programmable Solvent Module 126 and HP Model 79875A UV Detector and the following parameters:

a. Chromatographic column - Altrex Ultrasphere® ODS, 4.6 x250 mm, 5 um particle area

b. Mobile phase - Acetonitrile/water/1,4 Dioxane (45:45:10), flow 3.0 mL/min

c. Temperature - Ambient

d. Detector wavelength - 254 nM

Results (see enclosed table).

Summary

Of the one hundred twenty (120) vegetation samples analyzed, forty-eight (48) had residues with a high of 6.79 parts per million (ppm).

Residue Results of Dimilin in Vegetation Samples Received for the Gypsy Moth Program - Fiscal Year 1989

Lab Number	Site Number	County, State	Type of Sample	No. of Treatments Applied	Treatment Dates	Date Sample Collected	Residues (ppm) Dimilin
AA16969	CC0101	Luzerne, PA	Leaves	0	NA	06/02/89	<0.5
AA16970	CC0201	"	"	0	NA	06/02/89	<0.5
AA16971	CC0301	"	"	0	NA	06/02/89	<0.5
AA16972	CC0102	"	"	0	NA	06/02/89	<0.5
AA16973	CC0202	"	"	0	NA	06/02/89	<0.5
AA16974	CC0302	"	"	0	NA	06/02/89	<0.5
AA16975	CC0103	"	"	0	NA	06/02/89	<0.5
AA16976	CC0203	"	"	0	NA	06/02/89	<0.5
AA16977	CC0303	"	"	0	NA	06/02/89	<0.5
AA16978	CC0104	"	"	0	NA	06/02/89	<0.5
AA16979	CC0204	"	"	0	NA	06/02/89	<0.5
AA16980	CC0304	"	"	0	NA	06/02/89	<0.5
AA16981	CC0105	"	"	0	NA	06/02/89	<0.5
AA16982	CC0205	"	"	0	NA	06/02/89	<0.5
AA16983	CC0305	"	"	0	NA	06/02/89	<0.5
AA16984	CC0106	"	"	0	NA	06/02/89	<0.5
AA16985	CC0206	"	"	0	NA	06/02/89	<0.5
AA16986	CC0306	"	"	0	NA	06/02/89	<0.5
AA16987	CC0107	"	"	0	NA	06/02/89	<0.5
AA16988	CC0207	"	"	0	NA	06/02/89	<0.5
AA16989	CC0307	"	"	0	NA	06/02/89	<0.5
AA16990	CC0108	"	"	0	NA	06/02/89	<0.5
AA16991	CC0208	"	"	0	NA	06/02/89	<0.5
AA16992	CC0308	"	"	0	NA	06/02/89	<0.5
AA16993	CC0109	"	"	0	NA	06/02/89	<0.5
AA16994	CC0209	"	"	0	NA	06/02/89	<0.5
AA16995	CC0309	"	"	0	NA	06/02/89	<0.5
AA16996	CC0110	"	"	0	NA	06/02/89	<0.5
AA16997	CC0210	"	"	0	NA	06/02/89	<0.5
AA16998	CC0310	"	"	0	NA	06/02/89	<0.5

Lab Number	Site Number	County, State	Type of Sample	No. of Treatments Applied	Treatment Dates	Date Sample Collected	Residues (ppm) Dimilin
AA16999	100101	Luzerne, PA	Leaves	1	06/03/89	06/03/89	0.7
AA17000	100201	"	"	1	06/03/89	06/03/89	0.55
AA17001	100301	"	"	1	06/03/89	06/03/89	<0.5
AA17002	100102	"	"	1	06/03/89	06/03/89	<0.5
AA17003	100202	"	"	1	06/03/89	06/03/89	0.53
AA17004	100302	"	"	1	06/03/89	06/03/89	<0.5
AA17005	100103	"	"	1	06/03/89	06/03/89	1.15
AA17006	100203	"	"	1	06/03/89	06/03/89	<0.5
AA17007	100303	"	"	1	06/03/89	06/03/89	<0.5
AA17008	100104	"	"	1	06/03/89	06/03/89	<0.5
AA17009	100204	"	"	1	06/03/89	06/03/89	<0.5
AA17010	100304	"	"	1	06/03/89	06/03/89	<0.5
AA17011	100105	"	"	1	06/03/89	06/03/89	0.622
AA17012	100205	"	"	1	06/03/89	06/03/89	<0.5
AA17013	100305	"	"	1	06/03/89	06/03/89	<0.5
AA17014	100106	"	"	1	06/03/89	06/03/89	3.01
AA17015	100206	"	"	1	06/03/89	06/03/89	0.70
AA17016	100306	"	"	1	06/03/89	06/03/89	<0.5
AA17017	100107	"	"	1	06/03/89	06/03/89	0.68
AA17018	100207	"	"	1	06/03/89	06/03/89	<0.5
AA17019	100307	"	"	1	06/03/89	06/03/89	<0.5
AA17020	100108	"	"	1	06/03/89	06/03/89	<0.5
AA17021	100208	"	"	1	06/03/89	06/03/89	<0.5
AA17022	100308	"	"	1	06/03/89	06/03/89	<0.5
AA17023	100109	"	"	1	06/03/89	06/03/89	<0.5
AA17024	100209	"	"	1	06/03/89	06/03/89	2.99
AA17025	100309	"	"	1	06/03/89	06/03/89	3.19
AA17026	100110	"	"	1	06/03/89	06/03/89	<0.5
AA17027	100210	"	"	1	06/03/89	06/03/89	1.56
AA17028	100310	"	"	1	06/03/89	06/03/89	3.26
AA17029	200101	"	"	1	06/01/89	06/01/89	<0.5

Lab Number	Site Number	County, State	Type of Sample	No. of Treatments Applied	Treatment Dates	Date Sample Collected	Residues (ppm) Dimilin
AA17030	200201	Luzerne, PA	Leaves	1	06/01/89	06/01/89	<0.5
AA17031	200301	"	"	1	06/01/89	06/01/89	<0.5
AA17032	200102	"	"	1	06/03/89	06/01/89	3.32
AA17033	200202	"	"	1	06/01/89	06/01/89	2.68
AA17034	200302	"	"	1	06/01/89	06/01/89	<0.5
AA17035	200103	"	"	1	06/01/89	06/01/89	<0.5
AA17036	200203	"	"	1	06/01/89	06/01/89	<0.5
AA17037	200303	"	"	1	06/01/89	06/01/89	<0.5
AA17038	200104	"	"	1	06/01/89	06/01/89	6.14
AA17039	200204	"	"	1	06/01/89	06/01/89	<0.5
AA17040	200304	"	"	1	06/01/89	06/01/89	1.07
AA17041	200105	"	"	1	06/01/89	06/01/89	4.17
AA17042	200205	"	"	1	06/01/89	06/01/89	1.67
AA17043	200305	"	"	1	06/01/89	06/01/89	1.03
AA17044	200106	"	"	1	06/01/89	06/01/89	0.94
AA17045	200206	"	"	1	06/01/89	06/01/89	1.31
AA17046	200306	"	"	1	06/01/89	06/01/89	1.83
AA17047	200107	"	"	1	06/01/89	06/01/89	1.70
AA17048	200207	"	"	1	06/01/89	06/01/89	<0.5
AA17049	200307	"	"	1	06/01/89	06/01/89	1.21
AA17050	200108	"	"	1	06/01/89	06/01/89	1.69
AA17051	200208	"	"	1	06/01/89	06/01/89	2.23
AA17052	200308	"	"	1	06/01/89	06/01/89	1.67
AA17053	200109	"	"	1	06/01/89	06/01/89	0.98
AA17054	200209	"	"	1	06/01/89	06/01/89	<0.5
AA17055	200309	"	"	1	06/01/89	06/01/89	<0.5
AA17056	200110	"	"	1	06/01/89	06/01/89	<0.5
AA17057	200210	"	"	1	06/01/89	06/01/89	0.53
AA17058	200310	"	"	1	06/01/89	06/01/89	<0.5
AA17059	450101	"	"	1	06/03/89	06/03/89	1.31
AA17060	450201	"	"	1	06/03/89	06/03/89	<0.5

Lab Number	Site Number	County, State	Type of Sample	No. of Treatments Applied	Treatment Dates	Date Sample Collected	Residues (ppm) Dimilin
AA17061	450301	Luzerne, PA	Leaves	1	06/03/89	06/03/89	0.88
AA17062	450102	"	"	1	06/03/89	06/03/89	<0.5
AA17063	450202	"	"	1	06/03/89	06/03/89	0.61
AA17064	450302	"	"	1	06/03/89	06/03/89	<0.5
AA17065	450103	"	"	1	06/03/89	06/03/89	6.54
AA17066	450203	"	"	1	06/03/89	06/03/89	<0.5
AA17067	450303	"	"	1	06/03/89	06/03/89	5.43
AA17068	450104	"	"	1	06/03/89	06/03/89	4.62
AA17069	450204	"	"	1	06/03/89	06/03/89	4.11
AA17070	450304	"	"	1	06/03/89	06/03/89	1.88
AA17071	450105	"	"	1	06/03/89	06/03/89	<0.5
AA17072	450205	"	"	1	06/03/89	06/03/89	0.56
AA17073	450305	"	"	1	06/03/89	06/03/89	<0.5
AA17074	450106	"	"	1	06/03/89	06/03/89	<0.5
AA17075	450206	"	"	1	06/03/89	06/03/89	<0.5
AA17076	450306	"	"	1	06/03/89	06/03/89	1.16
AA17077	450107	"	"	1	06/03/89	06/03/89	<0.5
AA17078	450207	"	"	1	06/03/89	06/03/89	<0.5
AA17079	450307	"	"	1	06/03/89	06/03/89	2.46
AA17080	450108	"	"	1	06/03/89	06/03/89	<0.5
AA17081	450208	"	"	1	06/03/89	06/03/89	6.32
AA17082	450308	"	"	1	06/03/89	06/03/89	1.57
AA17083	450109	"	"	1	06/03/89	06/03/89	1.18
AA17084	450209	"	"	1	06/03/89	06/03/89	1.30
AA17085	450309	"	"	1	06/03/89	06/03/89	1.30
AA17086	450110	"	"	1	06/03/89	06/03/89	6.79
AA17087	450210	"	"	1	06/03/89	06/03/89	5.69
AA17088	450310	"	"	1	06/03/89	06/03/89	2.99

Lower limit of detection = 0.5 parts per million (ppm).

Laboratory Screening of Candidate Pesticides
and Microbials Against the Gypsy Moth
October 1, 1988 - September 30, 1989

Project Number:	GM 78.1.3
Project Title:	Laboratory Screening of Candidate Pesticides and Microbials Against the Gypsy Moth
Report Period:	October 1, 1988 - September 30, 1989
Report Type:	Interim
Project Leaders:	W. H. McLane and J. A. Finney

The objectives of this laboratory screening project are to collect and evaluate mortality data on experimental and registered compounds potentially useful for gypsy moth control, and to select materials for field studies and further development. These tests are designed to identify new materials and to increase the effectiveness of registered products.

Our main emphasis is development of new and registered materials that may improve treatments of gypsy moth in isolated infestations.

Unless otherwise stated, all tests have been conducted with our standard red oak seedling technique. Test insects are of the New Jersey strain and have been laboratory reared on artificial diet.

Five tender oak seedlings are treated with each test sample and allowed to dry for 3 hours. Twenty newly moulted, 2nd-instar gypsy moth larvae are then introduced onto each plant. Plants with test insects are then hold in an environmental chamber at 76°F and 55% RH. Insect mortality and seedling defoliation are recorded over a period of time. Five untreated seedlings are used as a control.

Materials are also tested for their stability when exposed to rainfall and ultraviolet light. Approximately 3 hours following treatment, plants are exposed to rainfall and/or ultraviolet light. They are then dried under a fan if necessary, and a standard bioassay determines effects.

During the past few years the majority of our laboratory work has been directed to the development of more efficacious *Bacillus thuringiensis* formulations. This work continued during this reporting period.

A new *Bt* carrier was tested and found to be very active with most formulations. A number of laboratory tests were conducted with the material and a limited outdoor residue test.

The data in Tables 1-2 are a result of receiving ABG-7022 with the active *Bt* already incorporated into the formulation. In all other tests the *Bt* was added to the ABG-7022 in the laboratory just before testing.

Table 69. Feeding comparison test of 2 Entice mixes, 7 *Bt* formulations, and Control. Average percentage of feeding after 24 hours (all *Bt* formulations at 16 BIU/gal/solution).

Treatment	Test A Spray Tower Method	Test B Spray Tower Method	Test C Brush Method
Dipel 8L	8.7	5.3	.7
Biobit	6.2	9.0	.3
San-415	5.0	5.5	.7
Condor Oil	3.6	7.1	.2
Foray	5.6	11.0	1.7
Thuricide 48LV	1.4	7.5	.9
Entice 5%	29.5	46.5	10.0
Entice 15%	22.6	35.0	11.2
Dipel 8AQ	5.7	8.0	1.1
Control	14.1	31.0	9.2

Six tests were conducted with Dimilin during this period.

Testing was conducted using our standard red oak seedling technique. Five seedlings were treated with each dilution and then exposed to 20 newly moulted laboratory-reared gypsy moth larvae. Plants and larvae were then held in an environmental chamber at 78°F at 55% RH. Larval mortality was recorded over a period of time. When seedlings were completely defoliated, larvae were transferred to artificial diet.

Table 70. Percent mortality of 2nd instar larvae following a 7-day exposure to oak seedlings treated with undiluted applications of Dimilin (special low volume formulation) and exposed to rainfall.

Dosage/rate/acre	Inches rain	Larval mortality after a 7-day exposure
.03 lbs. AI/16 oz.	-	100
.03 lbs. AI/16 oz.	1.0	100
.02 lbs. AI/16 oz.	2.0	100
.03 lbs. AI/32 oz.	-	100
.03 lbs. AI/32 oz.	1.0	100
.03 lbs. AI/32 oz.	2.0	100
.015 lbs. AI/32 oz.	-	100
.015 lbs. AI/32 oz.	1.0	100
.015 lbs. AI/32 oz.	2.0	100
Control	-	0
Control	2.0	14

Table 71. Percent mortality of 2nd instar larvae following 4-7 and 10 day exposure to oak seedlings treated with undiluted applications of Dimilin (special low volume formulation) and exposed to rainfall.

Formulation	Inches rain	Hours drying time	Percent mortality		
			4 days	7 days	10 days
Dimilin B					
.03 lbs. AI/32 oz./A	-	-	39	100	100
	2.0	.25	46	95	100
	5.0	3.5	52	100	100
Dimilin C					
.03 lbs. AI/16 oz./A	-	-	41	100	100
	2.0	.25	35	100	100
	5.0	3.5	47	100	100
Dimilin E					
.015 lbs. AI/32 oz./A	-	-	49	100	100
	2.0	.25	68	99	100
	5.0	3.5	38	100	100
Control	-	-	0	0	0
	5.0	-	0	0	1

Table 72. Percent mortality of 2nd instar larvae following a 4 and 7 day exposure to oak seedlings treated with Dimilin 2F material used for 1987 field tests in West Virginia.

Sample	Dosage/rate	Percent mortality	
		4 days	8 days
I	.0625 lbs. AI/32 oz./A	70	100
	.0312 lbs. AI/16 oz./A	61	100
	.0156 lbs. AI/8 oz./A	76	100
	.0078 lbs. AI/4 oz./A	58	82
II	.0312 lbs. AI/32 oz./A	66	98
	.0156 lbs. AI/16 oz./A	59	100
III	.0625 lbs. AI/16 oz./A	63	100
	.0312 lbs. AI/8 oz./A	47	98
	.0156 lbs. AI/4 oz./A	63	90
Control	--	1	1

Table 73. Percent mortality of 2nd instar larvae following a 4 and 7 day exposure to oak seedlings treated with Dimilin (special formulations) used in 1988 Pennsylvania field trials.

Dosage/rate/acre	Percent mortality	
	4 days	7 days
.03 lbs. AI/16 oz.	84	100
	76 1/	100
.03 lbs. AI/32 oz.	76	100
.03 lbs. AI/64 oz.	58	100
.03 lbs. AI/128 oz.	79 2/	100
Control	0	2

1/ After material was strained
2/ Dimilin 25W

Small amounts of Dimilin 25W were applied to oak seedlings and then exposed to 2nd instar gypsy moth larvae. A droplet 400 ul in size was used for the test.

Table 74. Percent mortality of 2nd instar larvae following a 4-9 and 14 day exposure to oak foliage treated with single and multiple droplets of Dimilin 25W.

Mix	Droplets per	Percent mortality		
		4 days	9 days	14 days
.06 lbs./gal/sol	1 drop/leaf	15	40	50
	1 drop/cm^2	42	91	91
	3 drops/cm^2	29	100	100
.03 lbs./gal/sol	1 drop/leaf	28	58	80
	1 drop/cm^2	51	99	100
	3 drops/cm^2	46	98	100
Control	--	0	0	0

Table 75. Percent mortality of 2nd instar larvae following an 8-day exposure to oak seedlings treated with Dimilin on various degrees of wet foliage.

Formulation	Dosage/rate acre	Foliage degree of wetness	Percent mortality
Dimilin 25W	.03 lbs./gal	Dry	100
Dimilin 25W	.03 lbs./gal	wet to point of run-off[1/]	100
Dimilin B	.03 lbs./32 oz.	Dry	100
Dimilin B	.03 lbs./32 oz.	wet to point of run-off[1/]	100
Dimilin C	.03 lbs./16 oz.	Dry	100
Dimilin C	.03 lbs./16 oz.	wet to point of run-off[1/]	99
Dimilin E	.015 lbs./32 oz.	Dry	100
Dimilin E	.015 lbs./32 oz.	wet to point of run-off[1/]	100
Control	--	Dry	2

1/ Seedlings were dripping wet at time of Dimilin application.

Dimilin gave excellent results in all tests. Mortality was complete after a heavy 5.0 inches of rain.

San-839I and San-841I, insect growth regulators from Sandoz, Inc., were tested in the laboratory and compared to Dimilin 25W.

Table 76. Percent larval mortality and oak seedling defoliation following gypsy moth larvae exposure to seedlings treated with San-829I, San-841I and Dimilin 25W.

Material	Dosage/rate lbs.AI/gal/acre	Percent mortality			Percent defoliation
		4 day	8 day	12 day	2 day
San-839I	.05	8	59	79	92*
"	.025	2	67	78	98*
"	.012	0	58	100*	
San-841I	.05	3	100		80*
"	.025	9	83	100[1/]	78*
"	.012	21	92	100[1/]	
Dimilin 25W	.05	1	86	100[1/]	94*
"	.025	4	96	100[1/]	94*
"	.012	5	75	100	100
Control	--	0	0	0	100

1/ Reading after 10 days
* Changed to artificial diet

A test was conducted in which each material was exposed to various amounts of rainfall with bioassay following. Plants were treated with the "Insect Growth Regulators" and allowed to dry for three hours before being exposed to rainfall. After rainfall plants were dried in front of a fan and then tested as in Table 77. All testing was done at .03 lbs. AI/gallon/acre.

Table 77. Percent larval mortality and oak seedling defoliation following gypsy moth larvae exposure to seedlings treated with San-839I, San-841I and Dimilin 25W and then exposed to rainfall.

Material	Inches rain	Percent mortality			Percent defoliation
		2 day	6 day	10 day	2 day
San-839I	--	0	23	43	84
"	1.0	0	10	50	78
"	3.0	0	10	71	76
"	5.0	0	5	39	85
San-841I	--	0	100		87
"	1.0	0	99	100	100
"	3.0	0	99	100	47
"	5.0	0	100		70
Dimilin 25W	--	0	99	100	72
"	1.0	0	97	100	94
"	3.0	0	96	100	52
"	5.0	0	97	100	72
Control	--	0	0	0	83
"	5.0	0	0	0	80

* Larvae were changed to artificial diet after 2 days' exposure to treated foliage

In these tests San-841I was as effective as the standard Dimilin 25W in both dosage and weathering tests. San-839I was less effective than San-841I and Dimilin 25W. Heavy seedling defoliation occurred with all materials in the first two days of test insect exposure. This is common for "Insect Growth Regulators" using this test technique.

Standard weathering tests were conducted with EXP-60145A, an experimental material from Rhone-Poulenc Agricultural Co. Treated plants were dried for 3 hours before being exposed to rainfall.

1979 Field Tests of Bay SIR-8514, Dimilin and
Bacillus thuringiensis
October 1, 1979 - September 30, 1980

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Project Number: GM 9.1.2
Project Title: 1979 Field Tests of Bay SIR-8514, Dimilin and *Bacillus thuringiensis*
Report Period: October 1, 1979 - September 30, 1980
Report Type: Final
Project Leaders: W.H. McLane, J. A. Finney

ABSTRACT

The growth regulators Dimilin and SIR 8514 and two commercial formulations of *Bacillus thuringiensis* Berliner (Thuricide 16B and 24B) were evaluated for gypsy moth population suppression in mixed-hardwood forest. Reduction in egg mass density resulted from one application of SIR 8514 (0.03 lb AI/acre) at one-half gallon per acre. Eighty-two percent reduction in egg mass density was achieved with two applications of Thuricide 16B (8 BIU AI/acre) at one-half gallon per acre. The other Thuricide treatments failed to prevent population increases. This failure was partly attributed to rainfall which disrupted the spray schedule and possibly washed some deposited matereial from foliage. In contrast with previous field trials, Dimilin treatment coinciding with foliage budbreak did not effect control, suggesting inadequate coverage of expanding foliage.

Introduction

The evaluation of chemical and microbial insecticides is an important activity within a larger effort to develop economically and environmentally practical methods for managing gypsy moth populations. The Gypsy Moth Methods Development Center (Otis Air Base, MA) maintains an insecticide screening and field evaluation program to test the large number of compounds receiving consideration. This paper reports the findings of 1979 field trials conducted in the Pequannock Watershed Region of Northern New Jersey, in which two chemical insecticides and two commercial preparations of *Bacillus thuringiensis* Berliner (BT) were evaluated for gypsy moth population suppression and foliage protection.

Both chemical compounds evaluated were growth regulators (interfering with ecdysis by inhibiting chitin synthesis). Dimilin (Thompson-Hayward Chemical Co. Kansas City, KS) was selected for application at the onset of foliage expansion based on previous field trials which suggested that early Dimilin treatment effected foliage protection. SIR 8514 (Mobay Chemical Co., Kansas City, MO) was selected for field evaluation based on favorable results of laboratory tests.

The BT formulations included in these trials were Thuricide 16B and Thuricide 24B (Sandoz, Inc., Homestead, FL). Thuricide 16B tests were designed to compare the performance of two different rates of application and to explore the influence of application timing on population reduction. Thuricide 24B (currently nearing registration) was compared with Thuricide 16B at a standard dosage and rate of application. In addition, an inexpensive, non-centrifuged, preparation of Thuricide 24B was compared with a preparation which had been "super-centrifuged" prior to shipment.

Methods and Materials

Spray Plots - In order to make preliminary estimates of egg mass density in prospective test areas, a "five minute count" procedure was implemented. By this technique, an observer walked in a given direction for five minutes (avoiding atypical stands, trails, clearings), counting all visible current season egg masses. These counts were converted to egg masses/acre by the formula: EM/A = (EM/5 min.walk X 20) + 20. Using this procedure it was found that a tract of 36,000 acres in the Pequannock Watershed of New Jersey and managed by the Newark Watershed Conservation and Development Corporation harbored suitable infestations for the tests. Populations in this general area were estimated at ca. 50 egg masses per acre in April, 1979.

Twenty-seven square 50 acre plots were positioned in the aboved designated area. There were 3 replicates for each of seven treatments and 6 non-treated control plots. Boundry lines and plot corners were outlined with surveyor tape. At least one corner of each plot was readily accessible by road and adjacent plots were separated by at least 500 ft. The 15 plots scheduled to receive BT treatment and 3 control plots were positioned in areas which contained ca. 50-100 egg masses/acre. This relatively low density range was selected in order to determine the efficacy of BT at low population levels. Chemical treatment plots (6) and the remaining 3 control plots were placed in areas of higher density.

To monitor gypsy moth population levels throughout the test,a 4x 5 grid of 20 equidistant prism points (each separated by 150 ft) was established within the central ten acres of each plot.

Prior to treatment and again in the following autumn, egg mass counts were made at each prism point in all plots to assess egg mass density changes. The variable-radius and fixed-radius egg mass sampling techniques were used. A wedge prism of Basal Area Factor 20 was used to identify those live, overstory trees included in variable-radius counts. Trees bordering on acceptance were alternately accepted or rejected. An 8.25 ft radius outward from each sampling point denoted the area in which fixed-radius counts were conducted. Unfortunately, diameters of trees included in the variable-radius counts were not recorded, complicating the subsequent calculation of actual egg mass densities.

Five BT treatments and two chemical treatments were compared for performance (applications and related equipment are summarized in Tables 1 and 2). All applications were accomplished in May, 1979. The chemicals were applied as 25% wettable powders and Thuricide formulations were applied as aqueous concentrates. The Dimilin was prepared by agitation in a mixing tank equipped with a pump and by-pass system. The other materials were agitated within the spray plane hopper during flight to the spray plots.

Dimilin treatment was conducted in early May (Table 1) when hatch was estimated at 50%, coinciding with foliage budbreak. The SIR 8514 applications and initial applications of BT were conducted in mid-May (Table 1) when larvae were predominantly in the 2nd and 3rd instar. The second BT applications (and applications to those plots receiving one late Thuricide 16B treatment) were conducted in late-May (Table 1) when larvae were predominantly in the 3rd and 4th instar. The intended interval between successive BT applications was 7-10 days. However, the spray schedule was disrupted by rainfall which resulted in an interval of 11-17 days between successive BT applications (Table 1).

A Cessna Ag-Truck equipped with a conventional spray system was used to apply the chemicals and the first BT applications (Table 2). The spray plane yielded a 60 foot swath at 125 mph, from 20 feet above tree top level. Unfortunately rainfall delays and scheduling of this spray plane for use in other projects resulted in the use of a different aircraft for the second BT applications. A Bell 47G helicopter equipped with a conventional spray system was used for the second BT applications (Table 2). The helicopter yielded a 60 foot swath at 50 mph, from 20 feet above tree top level.

Radio communication was maintained between pilot, airport team and field crewmen to coordinate spray operations. During aerial applications, plot corners were marked by suspending helium-inflated weather balloons (1.5 ft. diam.) 10-20 feet above the forest canopy. Mixing and spraying equipment was thoroughly cleaned between applications.

Treatment performance was assesed from the standpoint of population reduction by conducting larval and pupal counts in the vicinity of each sampling point in each plot. These counts were accomplished by means of burlap bands stapled to live, overstory trees in the vicinity of each sampling point. Sampling points within chemical-treated plots and their corresponding control plots were surrounded with 10 burlap-banded trees. BT-treated plots only had 5 trees per point. All living larvae and (later) pupae on and within each burlap band were counted once as the season progressed.

Treatment effectiveness was also determined from the standpoint of foliage protection at termination of larval feeding. Five positions (including the outer corners and center of each sampling grid) were used to visually estimate defoliation (20% intervals) of the forest canopy in each plot.

Results and Discussion

As mentioned earlier, positioning of the various plots was based on preliminary egg mass density estimates. Three control plots were intended to represent the various BT plots and three control plots were intended to represent the various chemical plots on the basis of similar egg mass density estimates. However, the pre-spray egg mass counts conducted in the various control plots indicated considerable variation in population levels among them. Hence, the division of the six control plots into two groups was deemed artificial and they were pooled into one group for purposes of comparison with the various BT and chemical treatments (Table 3).

Since the diameters of trees included in the egg mass, larval and pupal counts were not recorded, conventional formulae used to compute densities of various life stages on a per acre basis were not applicable. The egg mass (fixed and variable-radius samples pooled), larval and pupal population densities (Table 3) were calculated using an estimate of 207.25 trees per acre as a conversion factor. This estimate was based on 40 samples of 10 trees measured in the vicinity of various plots, and included only trees measuring 6+ inches dbh. The calculated densities of the various life stages (Table 3) are probably conservative since many trees considered in the conversion factor were smaller in diameter than those employed for population sampling.

Pre-spray egg mass densities in plots receiving chemical treatments ranged 156-270 EM per acre (=205). Plots receiving BT treatments supported pre-spray densities of 22-429 EM per acre (=138). Untreated control plots pre-spray EM densities ranged between 58-411 EM per acre, averaging 247. In chemical plots, the pre-spray densities were above the expected minimum of 150 EM per acre, in agreement with the initial density estimates. However, the expected range of 50-100 EM per acre in BT plots was much narrower than was actually the case. Judging from this and the disparity among EM densities in the various control plots, we question the reliability of the five minute count technique at low densities.

The rainfall experienced in close association with several applications (Table 4) may have adversely affected the performance of some materials. Laboratory studies (Table 5) suggest that the effectiveness of Thuricide 16B may be severely reduced when large amounts of rainfall occur within 24 hours of application.

Larval counts were conducted when larvae were predominantly in the 4th and 5th instars. In general, larval density within individual plots did not reflect pre-spray EM density. Beyond treatment effects, a number of factors may have contributed to this. Large numbers of larvae dead from parasitism, predation and virus infection were found under several burlap bands.

Pupal densities within plots treated with chemicals were greater than the earlier larval densities! In contrast, most plots treated with BT showed a reduction in pupal densities from the earlier larval densities. We have no explanation for this but suspect it is related to intrinsic error in burlap sampling. These reverse trends in population density change are illustrated by the "Corrected Population Reduction" column of Table 3. These values represent larval mortality (occurring between the larval and pupal sampling periods) attributed to treatment with natural mortality (estimated from the control plots) removed.

Among all BT treatments, only the late single BT application failed to reduce the pupal population density below the earlier larval density. Thus, two successive BT applications are recommended over one late application of BT.

The defoliation estimates for the various treatments (Table 3) ranged between 11-30 percent defoliation; greatest defoliation occurred in the control plots. Unfortunately, the defoliation estimates of the various treatments do not reflect differences in treatment performance expressed as corrected population reduction. It is possible that the defoliation estimates actually represent differences in stand composition among the various plots, more so than differences in treatment performance.

Evidently the gypsy moth population was increasing in the general region of this study. In some cases, egg mass densities increased more in treated areas than in untreated areas (Table 3). In only three treatments were the postseason EM densities reduced below the pre-spray densities. Egg mass density was reduced 78 percent following treatment with SIR 8514. Eighty-two percent reduction in EM density resulted from two applications of Thuricide 16B (8 BIU AI/acre) at the rate of 0.5 gallons per acre. The control achieved by all other treatments was negligable.

The poor control afforded by early Dimilin application was disappointing, since similar treatments in previous field trials showed more favorable results. In order to obtain adequate coverage of surfaces likely to be consumed by larvae, we suggest that Dimilin treatments be applied according to conventional timing schedules.

The poor control effected by most Thuricide treatments was partly attributed to rainfall. Apart from disrupting the spray schedule, the rainfall experienced following several BT applications (Table 4) may have washed some deposited material from foliage. Laboratory studies (Table 5) suggest that the efficacy of Thuricide 16B may be seriously reduced by heavy rainfall. Perhaps this is also true of Thuricide 24B, although this remains to be determined under laboratory conditions.

Table 1. Summary of formulations, dosages, and dates of application.

Treatment Material	Formulation	Dose/Acre	Application Date(s)
Dimilin	25W	0.03 lb AI/0.5 gal	May 3
SIR 8514	25W	0.03 lb AI/0.5 gal	May 20
Thuricide	24B[1]	8 BIU AI/0.75 gal	May 18 & 30
Thuricide	24B[2]	8 BIU AI/0.75 gal	May 17 & 31
Thuricide	16B	8 BIU AI/0.75 gal	May 15 & 31
Thuricide	16B	8 BIU/AI/0.5 gal	May 15 & 31
Thuricide	16B	8 BIU AI/0.75 gal	May 27

1 Non-centrifuged formulation

2 Formulation super-centrifuged prior to shipment

Table 2. Specifications of the spray nozzles employed for the various treatment applications.

Application	Orifice	No.	P.S.I.	Screens
Dimilin	8004 flat fan	18	40	50-mesh slotted
SIR 8514	8004 flat fan	18	40	50-mesh slotted
1st application BT	8006 flat fan	18	40	50-mesh slotted
single applic. BT (by spray plane)	8006 flat fan	18	40	50-mesh slotted
2nd application BT (by helicopter)	8004 flat fan	8	40	50-mesh slotted

Table 3. Population density observations in treatment plots.[1]

Treatment	Pre-spray[2] Egg Masses per Acre	Post-season Egg Masses per Acre	Egg Mass[3] Density Change (%)	No. Larvae per Acre	No. Pupae per Acre	Corrected Population Reduction (%)	Percent Defoliation
Growth Regulators: (0.03 lb. AI/Acre)							
Dimilin	200	328	- 64	2543	6369	- 205	22
SIR 8514	210	46	78	894	1024	- 39	23
Thuricide: (8 BIU AI/Acre)							
24B 0.75 gal/Acre x 2[4]	136	133	2	5002	2728	34	19
24B 0.75 gal/Acre x 2[5]	140	187	- 34	5350	3108	29	25
16B 0.75 gal/Acre x 2	99	156	- 58	4518	2727	27	14
16B 0.5 gal/Acre x 2	255	45	82	2222	1149	37	21
16B 0.75 gal/Acre x 1	59	123	-108	2334	1965	- 2	11
Untreated checks:	247	360	- 46	5968	4904	-	30

1 Each treatment was replicated three times; there were six untreated check plots.

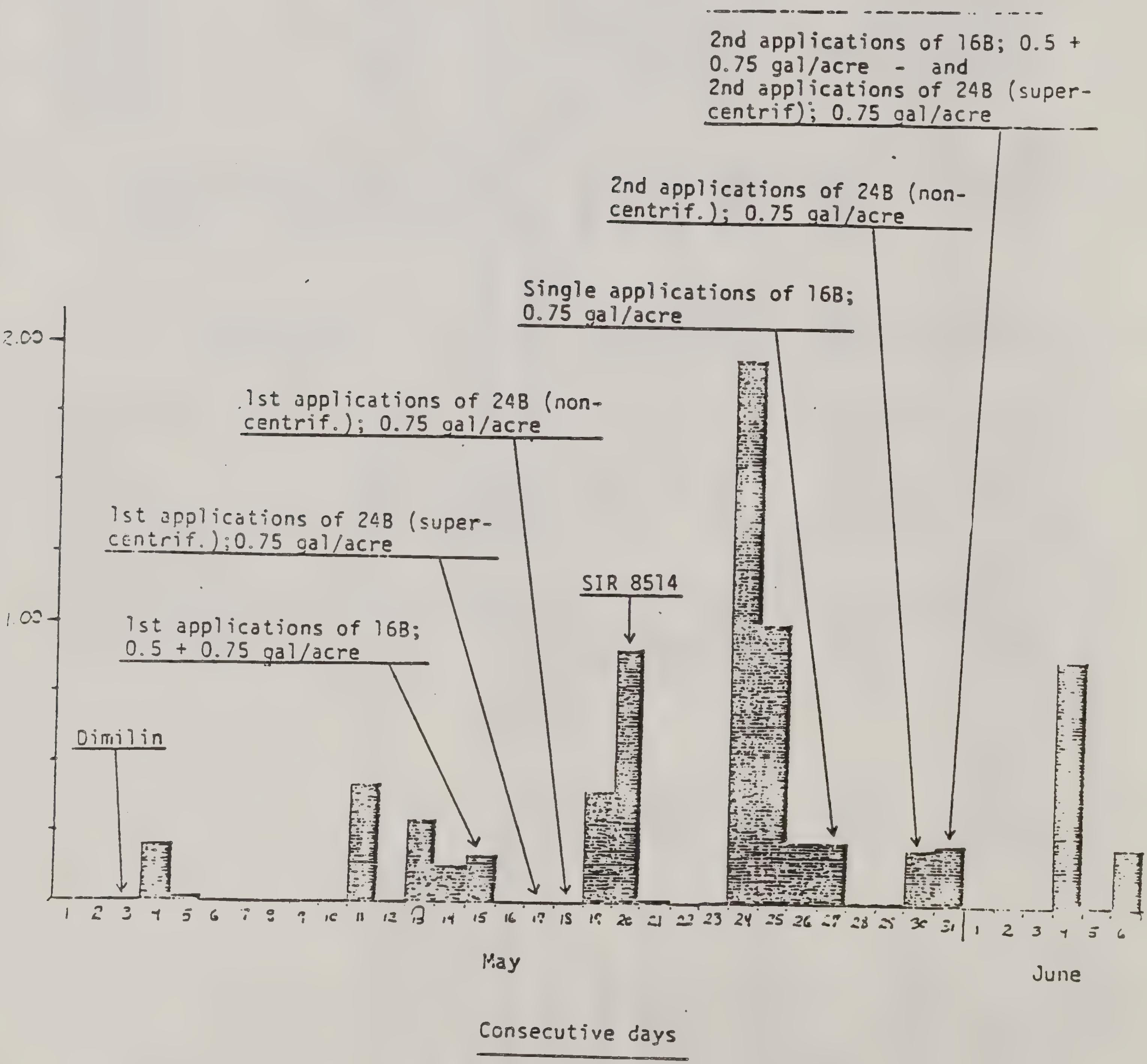
2 Fixed- and Variable-Radius samples incorporated into figures of all Egg Mass Density columns.

3 Abbott's Formula

4 Non-centrifuged formulation.

5 Super-centrifuged prior to shipment.

Table 4. Various application dates and subsequent inches of rainfall [1] encountered during the 1979 spray program.



1 Rain gauge readings from the Canistear Reservoir dam located near the center of the study region. Rainfall recorded at 8:00 a.m. daily.

Table 5. Summary of laboratory tests with Thuricide 16B, demonstrating the influence of rainfall following foliage treatment.[1]

Application[2] Dosage & Rate	Simulated rainfall inches and time administered	Percent Larval Mortality[3-4] 4 Days	8 Days	10 Days
8 BIU AI/2 g/a	-	36	98	100
8 BIU AI/2 g/a	2" within 1 hr	0	18	22
8 BIU AI/g/a	-	35	90	100
8 BIU AI/g/a	2" at 2.5 hrs	0	5	5
8 BIU AI/g/a	2" at 24 hrs	0	0	0
8 BIU AI/0.66 g/a	-	37	92	100
8 BIU AI/0.66 g/a	2" at 24 hrs	0	1	1
8 BIU AI/0.5 g/a	-	15	87	100
8 BIU AI/0.5 g/a	2" at 24 hrs	0	3	4

1 Data extracted from "Laboratory screening of candidate pesticides against the gypsy moth"; Table 25. Interim report by McLane, W.H., and J.A. Finney in the April - September 1979, Semi-Annual Laboratory Report: USDA, APHIS, PPQ, Otis Air Base, MA 02542.

2 Oak seedlings were treated, and infested with 100 second instar gypsy moth larvae following simulated rainfall as required.

3 Hours post-treatment with Thuricide 16B.

4 Days following larval introduction to treated foliage.

1986 Field Trials with Dimilin, Alsystin and <u>Bacillus thuringiensis</u>
October 1, 1985 - September 30, 1986

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Project Number: GM 5.1.1
Project Title: 1986 Field Trials with Dimilin, Alsystin and *Bacillus thuringiensis*.
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Report Type: Final
Project Leaders: W.H. McLane, J.A. Finney and T. Roland

Field trials were conducted in West Virginia, Pennsylvania and Rhode Island. Dimilin 25W and 2F(in 72 crop oil) were applied to gypsy moth infestations in West Virginia, at 4 time intervals from pre hatch to 2nd instar larval stage.

Alsystin 4F, Dimilin 25W and 2F(in 72 crop oil) were applied to gypsy moth infestations in Pennsylvania, at 4 time intervals from pre hatch to 2nd instar larval stage.

In Rhode Island, Dipel 8L, Thuricide 48LV and SAN 415 were sprayed against 3rd instar larvae. The *Bt* was used with the in-flight encapsulated materials BTLS, Black LS and Holdup.

All applications were made with the APHIS Ag-truck aircraft with a conventional spray system equipped with flat fan nozzles. The aircraft was piloted by Mr. Tim Roland, Aircraft Operations, Moore Field, Mission, Texas.

West Virginia

Insect growth regulators have proven to be extremely effective insecticides for use against gypsy moth larvae. Their mode of action is by contact as well as ingestion. Normally, excellent population reduction can be achieved with application of 0.25 to 1.0 ounces active ingredient per acre. After application onto foliage, peak mortality of 2nd instar gypsy moth larvae will occur in 5-7 days.

Because of their exceptional contact activity, it may be possible to achieve good control of early instar larvae by applying pre-foliage and pre-hatch treatments. Such treatments might also eliminate the threat of re-establishment by wind-blown early instar larvae. During 1976, Dimilin was applied to 3 fifty acre plots in Pennsylvania on April 30th. Foliage had not developed except on witch hazel that had 5% expansion. Approximately 50% of the gypsy moth eggs had hatched, but larvae had not left the egg masses. Average defoliation of treated areas was 10% with 65% in adjacent, untreated woodlands. Based on egg mass counts, populations were reduced by 87% in treated areas with a 72% increase in untreated check areas. Work continued with early application of Alsystin in 1984 and 1985. However, results were inconclusive due to poor timing of applications and the generally poor state of the insect population.

In 1986, early applications of Dimilin were applied in West Virginia at 4 time intervals to 100 acre woodland plots near Sleepy Creek State Public Hunting, Fishing and Camping Area. Treatments were replicated 3 times with all plots located along the top of a ridge at approximately 1800 feet elevation.

Table 1. Early application treatment schedule with Dimilin.

Material	Dosage/Rate	Treatment date
Dimilin 25W	.03 lbs AI/gal/acre	4/2/86 no budbreak/no hatch
Dimilin 2F(oil)	.03 lbs AI/gal/acre	4/14/86 no foliage/ 10% hatch
Dimilin 2F(oil)	.03 lbs AI/gal/acre	4/24/86 budbreak/general hatch
Dimilin 2F(oil)	.03 lbs AI/gal/acre	5/12/86 regular timing/2nd instar

Main objectives of the study were:

1. Determine if early treatments of Dimilin and Alsystin will prevent the establishment of wind-spread early instar gypsy moth larvae in areas outside of an isolated treatment plot.

2. Determine if pre-hatch and pre-foliage treatments can be effective in preventing defoliation and/or effecting population reduction.

3. Establish the earliest date that Dimilin and Alsystin can be effectively applied for controlling gypsy moth larvae.

4. Compare an oil formulation of Dimilin at two rates with Dimilin 25W applied at one rate.

Methods and Techniques

Plots were selected based on location and condition of the resident gypsy moth population. The Sleepy Creek area was selected because of the large egg masses present, little defoliation in 1985 and plots being accessible by a woods road.

Using a compass, topographical maps, rope and surveyor tape, plots were established and allocated to the various treatments. All plots were marked at each end with tape along the access road that ran through the center of each plot lengthways. Each plot was a square of 2,090 feet per side. The aircraft applied the spray material in a swath width of 75 feet, therefore, 14 swaths were treated on each side of the markers and/or wood road going parallel to the ridge. At time of treatment a yellow 30-inch balloon was flown at the end of each plot for aircraft guidance. An observation aircraft equipped with radio was flown overhead to assist in the guidance of the spray aircraft.

The aircraft was equipped with a 50-mesh in-line screen and quick drain valves. All 8006 flat fan nozzles utilized 50-mesh screens as the material was applied at 120 mph, 50 feet above the tree tops at approximately 40 PSI. Aircraft calibration was checked over the actual spray plots with each formulation.

Dimilin 25W and water was mixed in a nurse tank before being pumped into the aircraft. Dimilin 2F was mixed with 72nd dormant crop oil in the aircraft hopper. All aircraft operations were conducted out of the Martinsburg, West Virginia airport.

Treatment evaluation consisted of pre and post-spray egg mass counts, hatchability tests, defoliation estimates and larval collection and rearing. In early March nine 1/40 acre plots in each 100 acre spray plot were surveyed for egg masses. After fall foliage drop, post-spray counts were made using the same technique as described for pre-spray counts. At the time of pre-spray counts, egg masses were collected from each plot and incubated in the laboratory to establish percent hatch. Hatch was recorded at 80% or better.

In early July defoliation estimates were made in each sprayed and untreated check plot to determine percent defoliation. Defoliation was also observed from the air.

On May 1st, following general hatch and distribution of 1st instar larvae, 50 newly hatched larvae were collected at both the 1-6 foot and 20-40 foot levels in all plots treated with Dimilin by the first 3 applications. Larvae were also collected in all check plots. Collected insects were placed on artificial diet and reared over a period of time to record mortality. This technique was to determine if wind-blown larvae would survive if blown outside the treatment area.

Results

Table 2. Results of early Dimilin treatments in West Virginia.

Treatment date	Formulation	Pre EM/A	Post EM/A	Percent defoliation	Percent change (EM)
April 2	Oil 2F	6,566	527	13	-92
	25W	3,305	7,443	23	+56
April 14	Oil 2F	298	43	5	-86
	25W	1,858	444	7	-76
April 27	Oil 2F	1,449	47	5	-97
	25W	1,874	17	8	-99
May 12	Oil 2F	2,650	33	5	-99
	25W	2,073	80	5	-96
Check		4,470	521	13	-88

Table 3. Percent mortality of collected larvae from 3 early Dimilin treatments in West Virginia.

Date	Formulation	Percent mortality
April 2	Oil 2F	2
	25 W	4
April 14	Oil 2F	2
	25 W	6
April 27	Oil 2F	8
	25 W	16
Check		0

Although pre-spray egg masses averaged only 2,990 per acre, it appears that a population collapse may have occurred in the experimental area. Excellent control occurred in nearly all treatment plots, however, an 88% reduction took place in our check plots.

It would appear, based on the extensive defoliation just to the east of our plots, that strong southwesterly winds caused a movement of small larvae off the ridge top and out of the majority of our spray area. Therefore, the ridge tops are not suitable experimental areas to locate small plots. This would account for the population reduction recorded in all check plots. Based on the amount of defoliation just to the east of the plots where wind-blown larvae would have landed, one would say that larvae can survive if moved by wind out of an area that has received an early Dimilin application. This is further evident by the small amount of mortality that occured in larvae that were collected and reared on artificial diet. A problem with this analysis is the fact that we were not able to collect larvae high up in the trees and therefore may not have had samples representive of the population that might be succeptable to blow-out. Additional studies should be conducted making use of better sampling techniques.

Although little can be said, based on egg mass counts, defoliation estimates and our general observations within each plot indicate that we achieved good control with treatments 2, 3 and 4. In plots treated before foliage development we observed shot-holes in leaves after development of 50-75% expansion. At this time few if any larvae could be found in treated plots. This indicates that larvae moved from treated bark to foliage and fed, then went back to the bark and repeated this procedure until a lethal dosage had accumulated. During this period larvae would normally be too large to be spread by the wind velocity that was experienced. Therefore, population reduction was not due completely to blow-out that appeared to occur prior to foliage development.

Except for our first treatment we were able to record little difference between the oil and water base formulations. The oil appeared to be more effective than water in the first treatment. The main advantage of oil would

be to minimize evaporation. The main disadvantages would be the extra cost, handling and hang-up of spray. The durability of Dimilin 25W is excellent so we see no advantage of an oil base formulation to give longer residual. We feel it would be much more advantageous to develop a good 4 flowable formulation.

It appears that successful control of gypsy moth larvae can be achieved by applying Dimilin 25W in water or Dimilin 2F in oil at 0.03 lbs AI/gal/acre by aircraft as soon as any hatch appears on the south side of trees. This would allow an additional 2-3 weeks of treatment time. However, this study should be finalized in 1987 with early operational treatments being made to 5,000 acre plots at time of first hatch and at general hatch.

The West Virginia project was a cooperative effort by the West Virginia Department of Agriculture; United States Department of Agriculture, Forest Service, Morgantown, West Virginia; United States Department of Agriculture, Animal and Plant Health Inspection Service, Otis Methods Development Center, Otis ANGB, Massachusetts; and APHIS Aircraft Operations, Moore Field, Mission, Texas.

We extend special thanks to the West Virginia, Department of Agriculture personnel for their exceptional help and cooperation in the project.

Pennsylvania

Studies in Pennsylvania were very similar to those conducted in West Virginia with the objectives being the same. In addition to Dimilin being sprayed over 120 acre plots, Alsystin 4F was also tested on 500 acre sites.

Table 4. Early application treatment schedule with Dimilin and Alsystin in Pennsylvania.

Material	Dosage/Rate	Treatment dates
Alsystin 4F	.06 lbs AI/gal/acre	4/1/86 no budbreak/ no hatch
Dimilin 25W	.03 lbs AI/gal/acre	4/18/86 no foliage/ 2% hatch
Dimilin 2F(oil)	.03 lbs AI/.5 gal/acre	4/29/86 5% foliage/ general hatch
		5/14/86 regular timing/ 2nd instar 1/

1/ Dimilin was not applied on the last treatment date.

Alsystin was applied at .06 lbs AI/gal/acre and all Dimilin work in West Virginia, and Pennsylvania was with .03 lbs AI/gal and .5 gal/acre. Treatments in Pennsylvania were not replicated.

Plots were located on the southeast side of Blue Mountain in Tuscarora State Forest near Mifflintown, Pennsylvania. Mixing and loading operations were located at Mid-State Airport, Lewistown, Pennsylvania.

Methods and Techniques

All methods and techniques were very similar to those in West Virginia, with the following exceptions:

1. Pre and post-spray egg mass counts were made at 6 sites in each treatment and control plot using a 1/40 acre evaluation area.

2. Most corners were located and marked with balloons at time of treatment. The Cessna Ag-truck aircraft navigated off marker balloons and was not aided by an observation aircraft.

3. Larvae were collected for rearing in only the Alsystin plots of the first 3 treatments. As was the case in West Virginia, we had difficulties in trying to collect from high up in the trees.

Results

Table 5. Results of early Alsystin and Dimilin treatments in Pennsylvania.

Date	Formulation	Pre EM/A	Post EM/A	Percent change
April 1	Alsystin	6,760	120	- 98
	Dimilin 2F oil	4,500	0	-100
	Dimilin 25W	3,500	180	- 95
April 18	Alsystin	9,393	0	-100
	Dimilin 2F oil	4,000	27	- 99
	Dimilin 25W	4,000	100	- 98
April 29	Alsystin	5,603	43	- 99
	Dimilin	1,500	0	-100
	Dimilin 25W	1,800	0	-100
May 14	Alsystin	6,187	0	-100
Check		2,656	1,200	- 55

Defoliation was less than 10 percent in all treatment plots and 80 percent in check plots.

The 500 acre plot sprayed with Alsystin on April 1, 1986 was evaluated by state personel in mid-May and they found a number of larvae still actively feeding. They retreated 450 acres of the plot with Dimilin, and left 50 acres for our post-spray evaluation. For that treatment all egg counts and defoliation estimates were made within the 50 acres that were not retreated.

Based on egg mass reduction and defoliation estimates Dimilin and Alsystin were very effective at all time intervals studied. There appeared to be

little difference between dosages and only a slight difference between oil base and water base Dimilin formulations.

Two weeks after Alsystin was applied on April 29, thousands of dead larvae were observed in a 45 minute observation period. Within the Alsystin plot treated on April 18th only small numbers of live larvae could be observed in small isolated spots near the southern border. No post-spray egg masses were found within this plot.

As was the case in West Virginia, after foliage had developed to 50-70%, shot-holes were observed in most leaves indicating feeding by gypsy moth larvae. However, in most cases no larvae could be found, indicating accumulative effects of the spray.

Heavy virus infection occurred in larvae that were collected and reared in the laboratory. As a result we were unable to determine if larvae that may blow-out of a plot after early treatment might survive. As in West Virginia, we had great difficulty in collecting young larvae high up in the trees.

In conclusion, we can say that successful control of gypsy moth larvae can be achieved by applying Alsystin or Dimilin at .03 lbs AI/acre by aircraft as soon as hatch appears on the south side of trees. It also appears that successful control can be achieved with applications of Alsystin or Dimilin up to 2 weeks prior to any hatch.

This was a cooperative program with the Pennsylvania Division of Forest Pest Management, Mobay Chemical Corporation; Uniroyal Chemical Company and the United States Department of Agriculture, Animal and Plant Health Inspection Service. We thank the personnel involved in the program for their excellent help and cooperation.

Rhode Island

In 1985 Bacillus thuringiensis (Bt) was the material of choice for treating more than half of the total acres sprayed by air for control and/or eradication of gypsy moth infestations. Thuricide and Dipel were applied in a number of states as a single application at dosages of 12-20 BIU (Billion International Units) per acre. Rate of application ranged from 64-128 ounces per acre. In some states, isolated infestations were treated with multiple applications at 16 BIU in 96-128 ounces per acre. Large and small plots were treated along with narrow strips along roadways. Various types of helicopters, single and multi-engine fixed wing aircraft were used. Formulations were mixed in nurse tanks and dispersed by aircraft through flat fan and beecomist nozzles.

Where multiple applications of Bt were made, results were good based on post-spray adult trapping. Results with single applications varied greatly. One reason for this is the fact that where single applications are made, gypsy moth populations are generally high (5,000-10,000+ egg masses per acre). Pressure of migrating larvae from adjacent, unsprayed land is too great, especially with strip spraying. In some states, the use of Bt was a disaster, and in others, foliage protection was achieved.

Two new formulations of Bt were tested on 50 acre plots in Rhode Island during 1986. Holdup, a liquid polymer system and sticker agent was tested with oil base Dipel 8L. This material is a product of Greenshield of Washington. In laboratory tests, a combination of Holdup and Dipel 8L have resulted in faster kill, 20-30 percent more mortality and less defoliation than tests with Dipel 8L alone (Table 6). An encapsulant material developed at the University of Georgia was tested with Thuricide 48LV. Field studies on individual apple trees demonstrated longer residual with the addition of the encapsulant material (Table 7).

Table 6. Percent mortality of 2nd instar gypsy moth larvae and defoliation after a 3 and 4 day exposure to oak seedlings treated with Dipel 8L (oil) and Dipel 8L (oil) with Holdup at 12 BIU/96 oz/acre

Formulation	Percent Mortality - Defoliation			
	3 days		4 days	
	mor.	def.	mor.	def.
Dipel 8L	41	25	59	40
2ml 8L + 6ml 1128540	56	9	86	10
2ml 8L + 3ml H_2O + 3ml 1128540	83	3	95	3
2ml 8L + 6ml 1128540-0	81	6	94	6
2ml 8L + 3ml H_2O + 3ml 1128540-0	74	6	97	6
Check	2	88	3	91

Table 7. Percent mortality of 3rd instar gypsy moth larvae after a 4 day exposure to treated apple foliage collected from the field.

Material	Days after treatment											
	2	3	7	10	14	18	22	25	29	36	39	42
Thuricide 48LV	92	87	90	73	23	27	40	23	33	47	23	0
Thuricide 48LV + H1(1x1)	92	90	90	67	93	53	97	90	100	87	73	7
Thuricide 48LV + H4(1x1)	87	80	80	83	83	37	93	83	100	90	47	7
Thuricide 48LV + H5(1x1)	43	--	70	47	67	73	27	--	80	17	--	--
Thuricide 48LV + H5(2x1)	93	--	100	30	73	77	23	--	67	10	--	--
Thuricide 48LV + H6(2x1)	83	--	93	33	73	73	53	--	53	3	--	--
Thuricide 48LV + 3% Bond	90	87	93	97	67	30	60	37	57	30	100	7
Dipel 8L	83	97	80	87	50	63	83	60	83	37	50	3
Dipel 8L + 3% Bond	95	97	100	97	100	63	93	100	100	77	47	20
Bactospeine	95	80	87	80	50	43	93	77	23	23	43	7
Sevin XLR	100	100	100	100	100	100	100	100	100	100	73	100
Dimilin	100	100	100	100	100	100	100	100	100	100	100	100
Check 1	18	0	10	13	3	0	10	3	0	27	0	0
Check 2	0	6	3	10	7	0	0	0	0	0	20	0
Check 3	0	--	7	0	3	13	0	--	0	0	--	--

The following table is a summary of work conducted in 1986 Rhode Island experimental spray plots.

Table 8. 1986 Rhode Island field work with Dipel 8L, Thuricide 48LV, Holdup, encapsulant materials and SAN-415.

Formulation	Dosage BIU/96 oz/acre	Acres treated
Dipel 8L 1/	4	150
Dipel 8L + Holdup	4	150
Dipel 8L 1/	8	150
Dipel 8L + Holdup	8	150
Dipel 8L 1/	12	150
Dipel 8L + Holdup	12	100
Thuricide 48LV	8	150
48LV + 26% BTLS 2/	8	150
48LV + 26% BLACK LS 2/	8	150
48LV + 13% BTLS 3/	8	50
SAN 415 (NRD-12)	8	100
SAN 415 (NRD-12)	12	50
SAN 415 (NRD-12)	12 (Strip 2000x500')	23
SAN 415 (NRD-12)	16 (Strip 2000x500')	23
Check (untreated)		400

1/ Same amount of Holdup used as water.
2/ Encapsulant was 26% of total formulation.
3/ Encapsulant was 13% of total formulation.

The main objectives were:

1. Compare aerial applications of Dipel 8L(oil) with formulations of Dipel 8L(oil) mixed with Holdup.

2. Compare aerial applications of Thuricide 48LV to formulations of Thuricide 48LV mixed with the encapsulants BTLS and BLACK LS.

3. Compare SAN-415 (NRD-12 strain) to Dipel 8L and Thuricide 48LV (HD-1 strain).

4. Determine if Bt can be effectively used to protect foliage in strips 500 feet wide surounded by heavily defoliating gypsy moth populations (2,00-6,00 egg masses per acre).

Methods

A total of 38 experimental spray plots were established in Rhode Island at Arcadia Management Area, Wichaboxit Management Area and Alton Jones, University of Rhode Island Campus. Egg masses were large and averaged from 82-5,252 per acre with a mean of 1,072. Areas selected were mainly on state lands and had experienced little defoliation in 1985.

Using a compass, topographical maps, rope and surveyor tape, plots were established and allocated to the treatments listed in Table 8. Boundary lines were surveyed and marked in flourescent orange tape and each corner tree was marked with double flourescent orange tape and a tag identifying corner and plot number. Minimum distance between plots was 400 feet. Plots were located so that there would be a maximum number of corners on or near roadways.

Treatment evaluation consisted of pre and post-spray egg mass counts, egg hatchability tests, post-spray larval counts under burlap, defoliation observations and frass weighings.

Within the center 10 acres of each plot, 20 prism points were established, 5 points on 4 parallel lines. During March and early April, pre-spray egg mass counts were made at each prism point. New egg masses were counted and recorded on each prism tree and within each fixed radius plot. Prism tree DBH was also recorded. A limited number of egg masses were collected from the field and returned to the laboratory for hatchability tests. Hatch was uniform at 80-90 percent.

Burlap was placed on 6 oak trees at random in the center 10 acres of some plots. Counts were made on the number of gypsy moth larvae under each band following treatment. After each reading, all larvae were removed from under the burlaps. Readings continued until the start of pupation.

Six, 8 inch funnels were utilized in the center of some plots to collect frass following treatment. Funnels were located on stakes approximately 3 feet above the ground. Each funnel had a small plastic tube with screen end attached for collecting the frass. Frass collection continued until pupation had started.

At peak defoliation time (early July) a survey was conducted from the ground and by air. Total defoliation of all oak species was estimated at each prism point within each experimental plot. Aerial photographs were also taken of each spray plot and all checks.

Flow rates of each formulation were established at the laboratory with a miniature sprayer and new stainless steel flat fan spray tips. Final aircraft calibration was made over the first spray plot treated in each series. Spray distribution was checked with "Kromekote" cards placed in open areas on the ground. Encapsulant formulations appeared to be sticking to the spray cards when treatments were made early in the morning. It was reported that when mid-morning treatments were made some droplets rolled off from collection cards.

All applications were made with a Cessna Ag-truck aircraft equipped with a conventional spray boom and 8006 flat fan nozzles. The aircraft sprayed a 75 foot swath at 120 mph, approximately 50 feet over the target foliage. All nozzles were pointing straight down.

Mixing was done in a nurse tank and material was then pumped into the aircraft. Mixes were blended by agitation for at least 10 minutes before being loaded into the aircraft. The nurse tank was equipped with a 50-mesh, in-line screen. All mixing and aircraft operations were centered at Westerly Airport.

Bond, an agricultural spray sticker was used with all standard Bt application at a rate of 2.0 percent by volume. When Bt was mixed with Holdup, BTLS or Black LS, no sticker was added to the mix.

All treatments were made in the early morning hours before temperatures became too high. No applications were made in the late afternoon or early evening. The majority of larvae were in the early 3rd instar when spraying was conducted.

Results

Table 9. Results with Dipel 8L and Holdup, 1986.

Formulation	BIU/ 96 oz./Acre	Pre EM/A	Post EM/A	Average defoliation	Percent change (EM)
Dipel 8L	4	305	2,685	29	+780
Dipel 8L + Holdup	4	250	4,257	59	+1603
Dipel 8L	8	661	2,146	55	+225
Dipel 8L + Holdup	8	539	2,350	71	+336
Dipel 8L	12	1,971	2,948	56	+50
Dipel 8L + Holdup	12	2,068	2,309	52	+12
Check		396	3,381	91	+754

Table 10. Results with Thuricide 48LV and encapsulant materials, BTLS and Black LS.

Formulation	Pre EM/A	Post EM/A	Average defoliation	Percent change (EM)
Thuricide 48LV	401	3,579	48	+793
Thuricide 48LV + BTLS 26%	514	2,099	46	+308
Thuricide 48LV + BTLS 13%	1,165	5,678	100	+387
Thuricide 48LV + Black LS 26%	411	2,765	67	+573
Check	396	3,381	91	+754

Table 11. Results with the SAN-415(NRD-12).

BIU/ 96 oz./acre	Pre EM/A	Post EM/A	Average defoliation	Percent change(EM)
8	82	1,468	14	+1690
12	5,252	615	46	-88
12 (strip 500x2000')	1,032	7,621	17	+638
16 (strip 500x2000')	1,032	7,664	50	+643
Check	396	3,381	91	+754

Table 12. Total numbers of gypsy moth life stages recorded under burlaps.

Formulation	BIU/ acre	Life stages		
		Live larvae	Dead larvae	pupae
Thuricide 48LV	8	176	89	95
Thuricide 48LV + 26% BTLS	8	126	33	71
Thuricide 48LV + 13% BTLS	8	632	128	815
Thuricide 48LV + 26% Black LS	8	174	144	348
Dipel 8L	4	234	87	21
Dipel 8L + Holdup	4	326	79	39
Dipel 8L	8	677	236	512
Dipel 8L + Holdup	8	1,012	128	618
Dipel 8L	12	408	169	97
Dipel 8L + Holdup	12	420	69	65
Check		589	166	186

Table 13. Average grams of total frass collected for each treatment following spraying.

Treatment	Dosage BIU/acre	Average grams of frass
Dipel 8L	4	.41
Dipel 8L + Holdup	4	.42
Dipel 8L	8	.45
Dipel 8L + Holdup	8	.74
Dipel 8L	12	.56
Dipel 8L + Holdup	12	.47
Thuricide 48LV	8	.25
Thuricide 48LV + 26% BTLS	8	.29
Thuricide 48LV + 13% BTLS	8	.25
Thuricide 48LV + 26% Black LS	8	.40
Check		.37

At defoliation time numbers of larvae on tree trunks were observed in all plots as the defoliation estimates were made. A rating of 0-10 was given each treatment based on the numbers of larvae observed. The higher the number the less effective the treatment.

Table 14. Rating assigned each treatment based on numbers of larvae observed at peak defoliation time.

Treatment	Dosage BIU/acre	Rating
Dipel 8L	4	5.3
Dipel 8L + Holdup	4	4.3
Dipel 8L	8	5.3
Dipel 8L + Holdup	8	6.5
Dipel 8L	12	5.0
Dipel 8L + Holdup	12	4.5
Thuricide 48LV	8	5.6
Thuricide 48LV + 26% BTLS	8	4.8
Thuricide 48LV + 13% BTLS	8	9.0
Thuricide 48LV + 26% Black LS	8	7.3
SAN 415	8	2.0
SAN 415	12	5.0
SAN 415 (Strip)	12	4.0
SAN 415 (Strip)	16	4.0
Check		9.6

Based on all data collected, nearly all Bt treatments gave very poor results. Dipel with Holdup was no better than Dipel alone. Formulations of BTLS and Black LS mixed with Thuricide 48LV gave no more kill than Thuricide 48LV alone. This may have been due to the encapsulant drying out and not sticking to the foliage. However, material was observed on some foliage and spray cards indicated that some material did stick.

Results with SAN-415 were much more encouraging than in past years. Good foliage protection was achieved in the 50 acre plots and strip areas. It shows that strips of 500 feet can be successfully treated for foliage protection with SAN-415. The 2 strips had 100 percent defoliation all around them and they remained green except for 75 feet on each side where migration occured. However, the population was not reduced based on egg masses. We should continue to work with SAN-415 in 1987 as results this year were surely more impressive than in past years.

[illegible]

Thuricide 48LV [illegible]
Thuricide 48LV [illegible]
Thuricide 48LV [illegible]

SAN 415
SAN 415
SAN 415 [illegible]
SAN 415 [illegible]

Check

Laboratory Screening of Candidate Pesticides and Microbials Against the Gypsy Moth
October 1, 1984 - September 30, 1985

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Project Number: GM 8.1.3
Project Title: Laboratory Screening of Candidate Pesticides and Microbials Against the Gypsy Moth
Report Period: October 1, 1984 - September 30, 1985
Report Type: Interim
Project Leaders: W. H. McLane and J. A. Finney

The objectives of this laboratory screening project are to collect and evaluate mortality data on experimental and registered compounds potentially useful for gypsy moth control, and to select materials for field studies and further development. These tests are designed to identify new materials and to increase the effectiveness of registered products.

Unless otherwise stated, all tests have been conducted with our standard red oak seedling technique. Test insects are of the New Jersey strain and have been laboratory reared on artificial diet.

Bacillus thuringiensis (Bt) was sprayed on over half of the total acreage treated for gypsy moth control in 1985. In isolated infestations, multiple applications of Bt was the principle treatment used. Post-spray trapping in and around treatment areas indicated good control was achieved. Single and multiple applications resulted in few, if any, problems with phytotoxicity or car finishes. All formulations mixed and handled well. Laboratory studies during this reporting period were directed mainly to the development of more effective Bt formulations.

Four stickers were tested with Dipel 8L (aqueous), Dipel 8L (oil) and Thuricide 48LV. RA-1990 was the most effective of the stickers tested followed by Bond, Plyac and NuFilm 17. When used with oil base Dipel, all stickers were more active after a 2 hour exposure to natural sunlight. With Dipel 8L (aqueous) only Plyac and NuFilm 17 were more effective after ultraviolet exposure. With Thruicide 48LV, stickers were not effected by natural sunlight.

NuLure did not enhance the feeding of 2nd instar gypsy moth larvae at the dosages tested. With higher dosages of NuLure, much less feeding occurred than on untreated checks. As the dosage dropped, feeding increased. Tender red oak seedlings were treated in a laboratory spray chamber with 5 replications per treatment. Some plants were then exposed to 2 hours of natural sunlight and then treated along with other plants to 0.25 inches of rainfall. Plants were then dried under a fan and exposed to 20 newly molted 2nd instar gypsy moth larvae per plant. Each test consisted of 2 checks, with and without sunlight. Mortality and defoliation readings were made after 2 and 4 days at 80^{o}F and 55% RH.

Table 29. Percent mortality of 2nd instar gypsy moth larvae exposed to oak seedlings treated with insect growth regulators, CME-13406 and Dimilin at a rate of 1 gallon per acre.

Dosage lbs. AI/acre	Percent Mortality: CME-13406 after 4 days	CME-13406 after 6 days	Dimilin after 4 days	Dimilin after 6 days
0.06	75	97	81	96
0.03	65	99	82	96
0.015	70	93	75	96
0.0075	74	97	77	98
0.00375	65	97	81	100
0.0018	74	100	84	97
Check		0		0

Mavrik Aquaflow, a broad-spectrum fluvolinate insecticide, was tested against 2nd instar gypsy moth larvae.

Table 30. Percent mortality of gypsy moth larvae 1 and 4 days after exposure to oak seedlings treated with Mavrik.

Dosage lbs. AI/1.0 gal/Acre	Percent Mortality after 1 day	Percent Mortality after 4 days	Percent Defoliation after 4 days
0.25	47	88	1
0.125	13	74	2
0.0625	3	50	6
0.0312	1	25	9
0.0156	1	15	14
Check	0	0	100

Laboratory tests were conducted with 2 insect growth regulators from Union Carbide, UC-84572 and UC-86874. Dimilin was the test standard.

Table 31. Percent mortality of 2nd instar gypsy moth larvae after a 6 day exposure to plants treated with insect growth regulators.

Material	lbs. AI/gal/acre	Inches Rain	Percent Mortality
UC-84572	0.1	-	93
	"	1.0	92
	0.05	-	96
	"	1.0	94
	0.025	-	92
UC-86874	0.1	-	98
	"	1.0	96
	0.05	-	98
	"	1.0	80
	0.025	-	90
Dimilin	0.1	-	91
	0.05	-	94
"	0.025	-	97
Check	-	-	0

Laboratory testing was conducted with 3 Dimilin formulations. Dimilin 2 oil and Dimilin 4 aqueous formulations were compared with Dimilin 25 W/P.

Table 32. Percent mortality of 2nd instar gypsy moth larvae exposed to oak seedlings treated with 3 formulations of Dimilin and exposed to rainfall.

Formulation	Dosage lbs/acre	Percent Mortality Inches Rainfall 0.0	0.1	2.0	4.0
Dimilin 25 W	0.03	94			
	0.06	100	100	100	100
Dimilin 4 Aqueous	0.03	100			
	0.06	100	100	100	100
Dimilin 2 Oil	0.03	98			
	0.06	95	100	100	100
Check		0	0	0	1

Table 45. Percent mortality of various instar gypsy moth larvae following a topical application of Dimilin 25W from stock solutions of 0.06 lbs. AI/gal. and 0.03 lbs. AI/gal.

Microliters per Larva	Instar	Mortality Days After Treatment 6D	12D	16D	20D	24D	28D
1.0	II	100	--	--	--	--	--
0.2	II	100	--	--	--	--	--
1.0	III	70	90	90	95	--	--
0.2	III	25	60	90	95	--	--
1.0	IV	45	100	--	--	--	--
0.2	IV	10	15	50	75	75	80
1.0	V	0	20	30	35	--	--
0.2	V	0	0	0	0	0	0
1.0 1/	II	---	--	--	--	--	--
0.2 1/	II	60	90	100	--	--	--
1.0 1/	III	95	100	--	--	--	--
0.2 1/	III	10	40	80	90	90	--
1.0 1/	IV	45	55	60	85	90	--
0.2 1/	IV	0	0	15	60	90	--
1.0 1/	V	5	15	30	40	--	--
0.2 1/	V	5	5	5	--	--	--

1/ Applied from 0.03 lbs. AI/gal stock.

Table 46. Percent mortality of various instar gypsy moth larvae following a topical application of Dimilin 25W from stock solutions of 0.015 lbs. AI/gal and 0.0075 lbs. AI/gal.

Microliters per larva	Instar	Mortality Days After Treatment					
		6D	12D	16D	20D	24D	28D
1.0	II	--	--	--	--	--	--
0.2	II	45	80	100	--	--	--
1.0	III	95	100	--	--	--	--
0.2	III	5	16	60	100	--	--
1.0	IV	30	55	70	90	100	--
0.2	IV	0	0	20	65	80	85
1.0	V	5	20	20	--	--	--
0.2	V	0	0	0	0	0	0
1.0 1/	II	--	--	--	--	--	--
0.2 1/	II	45	85	100	--	--	--
1.0 1/	III	60	75	95	100	--	--
0.2 1/	III	0	20	60	95	--	--
1.0 1/	IV	30	35	50	70	90	--
0.2 1/	IV	0	0	20	35	50	--
1.0 1/	V	0	5	5	15	--	--
0.2 1/	V	0	0	0	0	0	0

1/ Applied from 0.0075 lbs. AI/gal stock.

Table 47. Percent mortality of various instar gypsy moth larvae following a topical application of 4 dosages of Dimilin 25W applied at 1.0 microliters per larvae.

Stock lbs AI/gal.	Instar	Mortality Days After Treatment 6 days	12 days	16 days	20 days
0.00375	II	55	75	75	75
	III	15	55	85	--
	IV	5	---	15	--
	V	0	5	---	--
0.00187	II	65	100	---	--
	III	0	25	75	--
	IV	0	---	35	--
	V	0	0	0	0
0.000935	II	45	95	100	--
	III	5	20	55	--
	IV	0	---	15	--
	V	0	0	0	0
0.000467	II	5	80	100	0
	III	0	10	30	0
	IV	0	0	0	0
	V	0	0	0	0
Acetone Only	II	0	0	0	0
	III	0	0	0	5
	IV	5	5	5	10
	V	0	0	5	10
Untreated Control	II	0	0	0	0
	III	0	0	0	5
	IV	0	0	5	5
	V	0	5	10	10

Regulatory Treatments
October 1, 1980 - September 30, 1981

Project Number: GM 6.1.5
Project Title: Regulatory Treatments
Report Period: October 1, 1980 - September 30, 1981
Report Type: Interim
Project Leaders: W. H. McLane, J. A. Finney

The main objective of this work is the development of new and improved treatments for regulated items moving from regulated areas to non-infested locations. This project is primarily directed toward the development of treatments for recreational vehicles, mobile homes and outdoor furniture.

A number of insecticide dusts have shown promises in laboratory and field tests. Plastic petri dishes were treated with a light film of insecticide dust and laboratory reared, 2 instar gypsy moth larvae were allowed to walk on the treated surface for given amounts of time. Larvae were then placed on artificial diet and mortality readings were made for a number of days. Tests always included 5 replicates and 100 test insects were exposed to each dosage and/or rate. Dust formulations were diluted in talc and a check was included with each test.

Table 1. Laboratory tests with Diazinon dust against 2nd instar gypsy moth larvae.

Percent Dust	Grams per Dish	Percent Mortality After 8 Days – Time on Treated Surface: 10 S	30 S	1 M	2 M	3 M	4 M	5 M
25	0.1	100	100	100	100	100	100	100
25	0.05	100	100	98	100	100	100	100
25	0.02	86	88	88	80	82	100	88
25	0.01	14	4	10	20	32	18	44
25	0.005	22	34	4	4	2	2	0
2	1.0	100	98	100	98	100	100	100
2	0.5	100	100	100	100	100	100	100
2	0.25	74	70	84	72	92	92	100
2	0.1	0	0	6	26	8	12	36
2	0.05	0	2	0	4	4	14	4
1	1.0	100	100	100	100	100	100	100
1	0.5	100	100	100	100	100	100	100
1	0.25	56	64	100	92	92	100	100
1	0.1	8	46	28	86	34	84	90
1	0.05	0	4	2	6	18	26	4
Control	TALC							0

Residual properties of 14 compounds were tested under field conditions. Two-hundred petri dishes were treated with 0.5g of each formulation, inverted and stored outside in trays. A plastic bag was placed over each stack to protect dishes from wind and rain. Dishes used for checks were also stored outside. On a weekly schedule, 10 dishes from each treatment and check were bioasayed in the laboratory.

Newly molted 2nd instar larvae were exposed to the treated surface for periods of 1 or 5 minutes. One-hundred test insects were exposed to each treatment. Following treatment, larvae were placed on artificial diet. Mortality readings were made over a period of days.

Table 14. Materials tested for residue.

Material	Dosage	Dust	Spray
Ambush	0.06 lbs./gal/sol		X
Baygon	10 %	X	
Diazinon	4 %	X	
Dimilin	5 %	X	
Dimilin	0.06 lbs./gal/sol		X
Dylox	10 %	X	
Imidan	10 %	X	
NC - 6897	1 %	X	
Orthene	10 %	X	
Pramex	5%	X	
SBP - 1382	10 %	X	
Sevin	10 %	X	
SIR-8514	5 %	X	
SIR-8514	0.06 lbs./gal/sol		X
Check			

Table 15. Residue test results with 14 formulations.

Material	Minutes Exposure	Percent Mortality After 4 Days — Days of Outside Aging: 0	7	14	21	28	35	42	49	56	63	70	77
Ambush 1/	1	100	100	100	99	100	100	98	94	96	67	100	97
	5	100	100	100	100	100	100	100	100	100	100	100	92
Baygon	1	3	0	0	0	0	0	1	3	3	0	3	1
	5	6	0	0	0	0	0	1	0	1	0	3	0
Diazinon	1	0	0	1	0	0	0	0	0	0	0	2	0
	5	0	0	2	0	0	0	8	0	0	0	3	1
Dimilin 2/	1	85	88	99	97	98	100	100	100	100	100	100	98
	5	97	99	99	100	100	100	100	100	100	100	100	100
Dimilin 1/	1	87	85	66	99	100	100	100	100	100	90	100	100
	5	73	87	96	100	100	100	100	100	100	100	100	100
Dylox	1	1	0	0	0	1	0	70	2	0	4	0	0
	5	0	1	1	0	0	0	5	0	0	4	1	0
Imidan	1	22	4	3	0	1	3	0	1	16	0	5	3
	5	18	15	1	19	4	6	11	20	28	5	14	13
NC-6897	1	24	12	1	3	0	0	1	1	3	0	0	2
	5	84	9	4	6	7	3	1	12	7	0	3	11
Orthene	1	7	1	6	8	6	25	27	12	3	2	65	20
	5	3	1	45	38	3	71	39	75	51	45	21	51
Pramex	1	100	46	11	56	41	37	42	70	10	31	9	43
	5	100	77	81	54	54	100	90	93	65	52	68	48
SBP-1382	1	4	0	0	0	0	0	0	0	0	0	1	7
	5	5	0	0	0	0	2	0	2	1	0	2	8
Sevin	1	50	35	6	55	22	39	44	63	43	47	5	72
	5	83	67	15	80	80	74	2	83	68	85	2	65
SIR-8514 2/	1	99	81	99	100	100	99	97	98	100	100	96	100
	5	100	98	98	100	100	100	100	100	100	100	100	100
SIR-8514 1/	1	38	71	83	99	70	98	100	100	91	93	94	72
	5	68	86	100	100	93	99	100	100	100	96	100	84
Check	1	0	0	0	80	0	0	0	1	2	0	0	1
	5	2	0	0	15	0	0	0	0	2	0	15	5

Dimilin and SIR-8514 readings were after 14 days.
1/ Spray treatment
2/ Dust treatment

Laboratory Screening of Candidate Pesticides
and Microbials Against the Gypsy Moth
October 1, 1982 - September 30, 1983

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Project Number: GM 8.1.3
Project Title: Laboratory Screening of Candidate Pesticides and Microbials Against the Gypsy Moth
Report Period: October 1, 1982 - September 30, 1983
Report Type: Interim
Project Leaders: W. H. McLane and J. A. Finney

The objectives of this laboratory screening project are to collect and evaluate mortality data on experimental and registered compounds potentially useful for gypsy moth control, and to select materials for field studies and further development. These tests are designed to identify new materials and to increase the effectiveness of registered projects.

Unless otherwise stated, all tests have been conducted with our standard red oak seedling technique. Test insects are of the New Jersey strain and have been laboratory reared on artificial diet.

During 1983 a number of State and Federal agencies used Bacillus thuringiensis to treat gypsy moth infestations. In all, more B. thuringiensis was used in 1983 than any previous year. In most cases, single applications of 12 BIU/acre were very effective in controlling defoliation.

Although results were generally good with B. thuringiensis during 1982, there were many questions about stickers: which one to use, will it affect car paint, will it clog screens, how costly is it, what's in it, is it cleared for use and will it help stick the material to foliage? While there are a number of stickers available for use, further testing was conducted with formulations of B. thuringiensis and various sticking agents. The following tables summarize that work.

TABLE 1. Mortality of 2nd instar gypsy moth larvae 4 days after placement on oak foliage treated with 8 BIU of Dipel 4L and 2% sticker and exposed to various amounts of rain.

	Percent mortality				Percent defoliation after 3 days			
Sticker	0.05"	0.1"	0.2"	.5"	0.05"	0.1"	0.2"	0.5"
No sticker-no rain	60	42	64	60	10	16	6	16
No sticker	38	9	2	0	29	79	79	90
Polyco - 2142	11	12	15	8	54	63	46	66
Polyco - 522	24	2	6	2	39	72	71	79
Polyco - 2149	37	9	18	7	31	57	46	58
Rhoplex - AC33NP	24	2	24	30	29	70	46	68
TS-30	20	3	6	2	37	62	66	84
TS-85	22	7	8	4	40	65	50	77
TS-100	7	6	7	4	63	68	51	74
RA-1990			53				22	
Check	0	0	1	1	97	100	100	94

TABLE 18. Degree of phytotoxicity on foliage of 15 tree species treated with Dipel 6L, Dipel 8L and Thuricide 64BX, 48 hours prior to visual inspection.

Tree Species	Dipel 6L				Dipel 8L				Thuricide 64BX			
	N	L	M	H	N	L	M	H	N	L	M	H
Poplar				X				X				X
Red oak		X				X				X		
White oak			X				X			X		
Pine		X				X				X		
Plum	X				X				X			
Lilac			X				X				X	
Catalpa				X				X				X
Blueberry			X					X				X
Pear		X					X					X
Birch				X				X				X
Maple				X				X				X
Cucumber	X				X				X			
Peach	X				X				X			
Locust	X				X				X			
Ash	X				X				X			

Above test results based on a dilution of 1.0 part Bt. and 1.0 part water.

N - no evidence of burning
L - light burning and droplets vague
M - burning easy to see and very obvious
H - extensive burning and leaf curl

Four experimental insect growth regulators were tested. BTS-48011, a BFC product, and 141305, a BASF Wyandotte material, gave excellent results. Sumitomo products 4496 and 4624 gave very poor results when compared to Dimilin. Poor results were no doubt due to formulation and volume used.

TABLE 19. Mortality of 2nd instar gypsy moth larvae 6 days after placement on oak foliage treated with S-4496, S-4624 and Dimilin.

Lbs/acre	Percent mortality		
	S-4624	S-4496	Dimilin
0.125	0	1	100
0.0625	0	1	99
0.015	3	0	91
0.0075	1	1	92
0.0037	1	0	98
Check	0	0	0

TABLE 20. Mortality of 2nd instar gypsy moth larvae 6 days after placement on oak foliage treated with 141305I and Dimilin.

Lbs/acre	Percent mortality 141305I	Dimilin
0.25	94	98
0.125	97	98
0.0625	74	99
0.0312	75	97
0.0156	72	96
0.0078	51	98
0.0039	22	96
Check	0	0

TABLE 21. Mortality of 2nd instar gypsy moth larvae 6 days after placement on oak foliage treated with BTS-48011.

Lbs/acre	Percent mortality
0.003	100
0.0015	97
0.00075	75
0.000375	36
0.000187	15
0.0000935	0
Check	0

TABLE 22. Mortality of 2nd instar gypsy moth larvae 6 days after placement on oak foliage treated with BTS-48011 and exposed to various amounts of rain.

	Percent mortality			
Lbs/acre	No Rain	0.5"	1.0"	2.0"
0.4	100	100	100	100
0.2	100	100	100	100
0.1	100	100	100	100
0.05	100	100	100	100
0.025	100	99	100	100
0.0125	100	100	100	100
0.006	100	100	100	100
0.003	100	100	100	99

Two oil formulations of Orthene were tested using cottonseed oil as a solvent. We encountered some difficulty in mixing as the material became very thick.

Field Studies With Early Dimilin Applications in Delaware - 1988
October 1, 1987 - September 30, 1988

Project Number: GM 88.1.1C
Project Title: Field Studies With Early Dimilin Applications in Delaware - 1988
Report Period: October 1, 1987 - September 30, 1988
Report Type: Final
Project Leader: W. McLane, N. Schneeberger, L. Bradley, T. Roland and P. Bohne

The Animal Plant Health Inspection Service, Forest Service, Delaware Department of Agriculture and Uniroyal Chemical cooperated in a study to determine the usefulness of early applications of Dimilin for gypsy moth control.

Introduction

In 1986 the USDA Forest Service, Animal and Plant Health Inspection Service (APHIS), West Virginia Department of Agriculture, Pennsylvania Department of Environmental Resources and Uniroyal Chemical Company, Inc. cooperatively evaluated the effectiveness of Dimilin (diflubenzuron) applied as follows:

1. First sign of egg hatch
2. General hatch (100%)
3. Standard timing (ca. 30% foliage expansion; 1st & 2nd instar)

The results were not statistically conclusive, however, acceptable foliage protection and population reduction were achieved in several of the early-timed blocks to warrant further evaluation (McLane and Schneeberger 1986; McLane and Roland 1986).

The following year (1987) another field evaluation was carried out in West Virginia to evaluate Dimilin applied at:

1. First sign of egg hatch
2. General hatch (100% egg hatch with some dispersal)

Populations were significantly reduced in the block treated at general hatch, and no noticeable defoliation was detected. Post treatment populations were not significantly reduced in the area treated early, however, foliage protection was achieved in much of the block. The untreated check area was severely defoliated throughout. Based in part on these results, the Dimilin label was modified to permit treatment at general hatch (McLane 1987).

In 1988, the Forest Service and APHIS decided to again look at the effectiveness of earlier-timed Dimilin applications. The project was a cooperative effort between USDA Forest Service and APHIS, Delaware Department of Agriculture (DDA), Maryland Department of Agriculture (MDA) and Uniroyal Chemical Company, Inc. The objectives of this evaluation were to:

1. Determine if Dimilin applied at the beginning of egg hatch would protect foliage and reduce gypsy moth populations.

2. Determine the effectiveness of early-timed Dimilin applications compared to operationally timed-applications.

Methods and Materials

Project Area Selection

Nineteen (19) discrete woodlots ranging in size from 45 to 253 acres were located in Kent County, Delaware, and Caroline and Queen Annes Counties, Maryland, according to the following criteria:

1. No defoliation present the previous year.
2. Healthy, building populations with no overt evidence of virus.
3. Egg mass counts ca. 1000-3000/acre.

Fourteen (14) woodlots in Kent County, Delaware, were selected to receive the Dimilin treatments. These woodlots were previously scheduled for treatment by DDA in their planned gypsy moth suppression program. Four woodlots in Caroline and Queen Annes Counties, Maryland, and the remaining one in Kent County, Delaware served as untreated checks.

Seven (7) of the 14 woodlots were treated when about 5 percent of the egg masses showed signs of hatch (early timing). This was determined by walking the most southerly exposed edge of each woodlot daily, and observing a minimum of 100 egg masses for any sign of hatch. The woodlots were treated as they became ready until a total of 7 were treated. The treatments were made using the USDA, APHIS Cessna Ag-truck spray plane on April 11, 1988. The remaining 7 woodlots were treated on April 26 and 27 by DDA during their 1988 cooperative gypsy moth suppression project (standard timing). Applications were made using a Piper Pawnee Brave spray plane. All treatments were made at the rate of 0.03 lbs. active ingredient per acre (2 oz. Dimilin 25W) in 1.0 gallons total mix per acre.

Monitoring

Egg Quality Determinations - During March 1988, 10 egg masses, five above the one foot level and five below the one foot level, were collected and returned to the laboratory. The egg masses were held in petri dishes at 80°F and 55% relative humidity for at least 3 weeks. Emerging larvae were counted as were the number of non-eclosed larvae and the percent hatch calculated. A sample of larvae from each collection were reared on artificial diet through 4th instar to evaluate the general health of the population.

Foliage Development - At the time of treatment, foliage development estimates were made of the overstory and understory vegetation on a transect through the middle of each woodlot.

Egg Mass Counts - Ten (10) 1/40 acre fixed radius sampling plots were randomly established within the interior of each woodlot for pre- and post-treatment egg mass counts. Pre-treatment counts were conducted in March 1988 and post-treatment counts in October and November. An analysis of variance was conducted on the rate of change in the egg mass counts between treatment replicates to determine if population differences were significant.

Larval Counts - Five (5) representative chestnut or white oak trees near the center of each woodlot were banded with burlap. Each site was checked weekly and the number of larvae under each burlap band was counted and recorded.

Total larvae counted were compared between treatments.

Defoliation Estimates - Ground estimates of defoliation were made at each of the ten (10) egg mass survey plot locations in the woodlots. Two observers independently estimated oak defoliation (0-100%) at each location. The two estimates were averaged and assigned to one of the following categories: 0, 1-20 percent, 21-40 percent, 41-60 percent, 61-80 percent, and 81-100 percent. An analysis of variance test was used to determine if there were significant differences between the treatments.

Aerial detection surveys using sketch mapping techniques and hand-held photography were conducted by DDA. In addition, high altitude color, infrared optical bar camera photography was also obtained.

Results and Discussion

The stand conditions at the time of treatment are presented in Table 1. Egg hatch in the early Dimilin woodlots ranged from 4-13 percent and averaged 8% percent overall. The egg hatch was less than 10 percent in 6 of the 7 woodlots. Foliage development on the oak overstory ranged from 1-10 percent and averaged 4 percent overall. Oak leaf expansion was less than 5 percent in 6 of the 7 woodlots. In the woodlots that received the standard timed applications of Dimilin, egg hatch averaged 98 percent (range - 95-100%), and oak foliage development averaged 14 percent (range = 10-22%).

A summary of defoliation estimates and pre- and post-treatment egg mass counts is presented in Table 2. Oak defoliation averaged 5% in the standard treatments, 54% in the early treatments and 79% in the untreated check areas. Defoliation levels were significantly different (= 0.05) between all of the treatments (Figure 1, Table 3).

Post-treatment gypsy moth populations were reduced by the standard timed applications (23%) but increased in the early timed applications (446%) and the untreated checks (967%) (Figure 2, Table 3). Post-treatment egg mass counts were significantly different between the standard-timed applications and the untreated check areas, but not between the early treatments versus checks or the standard versus early treatments (= 0.05).

Under the conditions of this field evaluation, early timed applications of Dimilin provided greater foliage protection than not treating at all, but not as great as that provided by the standard timed applications. Current gypsy moth suppression projects are considered to be successful if defoliation is kept to a minimum of about 40 percent. Given this criterion, the early-timed Dimilin applications would likely fail to meet foliage protection objectives of suppression projects. The early-timed Dimilin applications failed to significantly reduce (= 0.05) residual gypsy moth populations compared to the untreated checks. Oddly enough, there was not a significant (= 0.05) difference between the standard-timed and early-timed applications either, even though egg mass counts were reduced by the former treatments in all woodlots, except one. This can probably be attributed to the limited number of woodlots comprising the project area. Additional replicates would likely have minimized the influence of any extreme intra-treatment variation.

This field evaluation did not demonstrate the expected degree of foliage

protection that was suggested by the 1987 project. Why this occurred is open to speculation. Misapplication in all seven blocks is not likely since the treatments were made during very favorable weather conditions, and spray deposit was observed on the spray cards in all of the treatment blocks. Perhaps some investigations should be initiated to determine if these disappointing results are related to limitations of the 25W formulation. The early-timed applications in 1987 were made with Dimilin 25W and Dimilin 2F formulations. We do know that the Dimilin 25W formulation is very susceptible to evaporation. It should also be noted that population reduction (23%) with the standard application was much less than one would expect. A reduction of 90-95% should have occurred.

In summary, the results of this field evaluation support the need to apply Dimilin 25W when general hatch has occurred (100%) and the larvae begin dispersing. Additional laboratory evaluations are recommended to determine the extent of Dimilin 25W formulation limitations, if any.

References

McLane, W. and N. Schneeberger. 1986. 1986 Field Trials with Early Application of Dimilin in West Virginia; pages 219-221, in the Proceedings of the 1986 Gypsy Moth Annual Review. December 1-4, 1986. Norfolk, Virginia.

McLane, W. and T. Roland. 1986. 1986 Field Trials with Early Application of Alsystin and Dimilin; pages 222-223 in the Proceedings of the 1986 Gypsy Moth Annual Review. December 1-4, 1986. Norfolk, Virginia.

McLane, W. 1987. early Application of Dimilin for Gypsy Moth Control; pages 193-199 in the Proceedings of the 1987 National Gypsy Moth Review. December 7-10, 1987. Charleston, West Virginia.

Table 1. Insect and host foliage development at the time of treatment. 1988 Early Dimilin Evaluation.

Treatment	Spray dates	Percent egg hatch	Percent oak leaf expansion
Standard	4/26-27	98	14
Early	4/11	8	4
Check	N/A	N/A	N/A

Table 2. Average oak defoliation levels and pre- and post-treatment egg mass counts by treatment. 1988 Early Dimilin Evaluation.

Treatment	N	Oak defoliation	Pre-treat. egg masses per acre	Post-treat. egg masses per acre	percent change
Standard	7	5	1549	1011	-23
Early	7	54	1709	8062	446
Check	5	79	1337	10860	967

Table 3. Interactions that show significant differences (oc=.05) between treatments. 1988 Early Dimilin Evaluation.

	Comparison		
Variable	Standard vs. check	Early vs. check	Early vs. standard
Oak defoliation	yes	yes	yes
Percent change of EM/A	yes	No	No

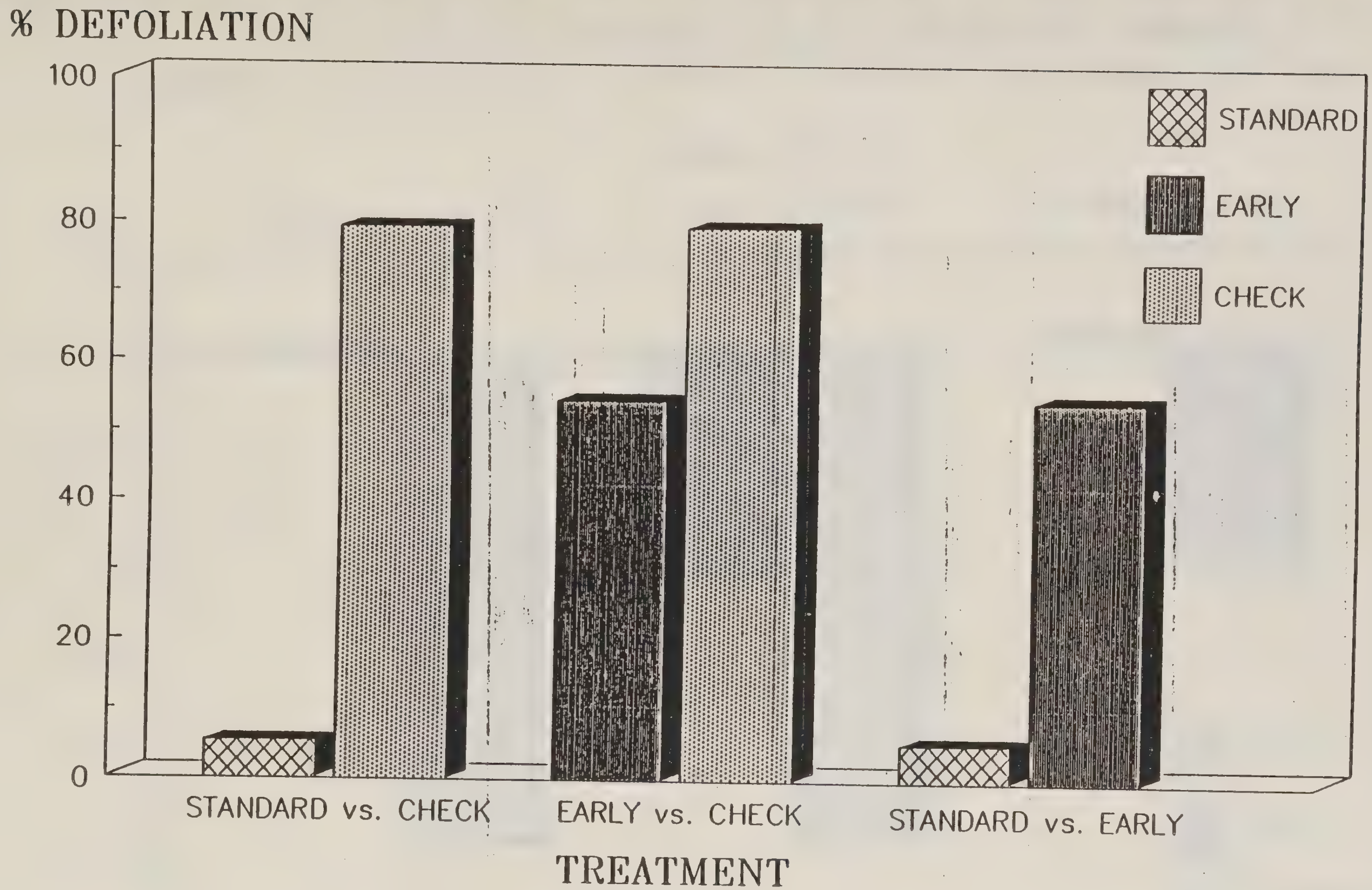

Figure 1. -- Comparison of oak defoliation between treatments. 1988 Early Dimilin Evaluation.

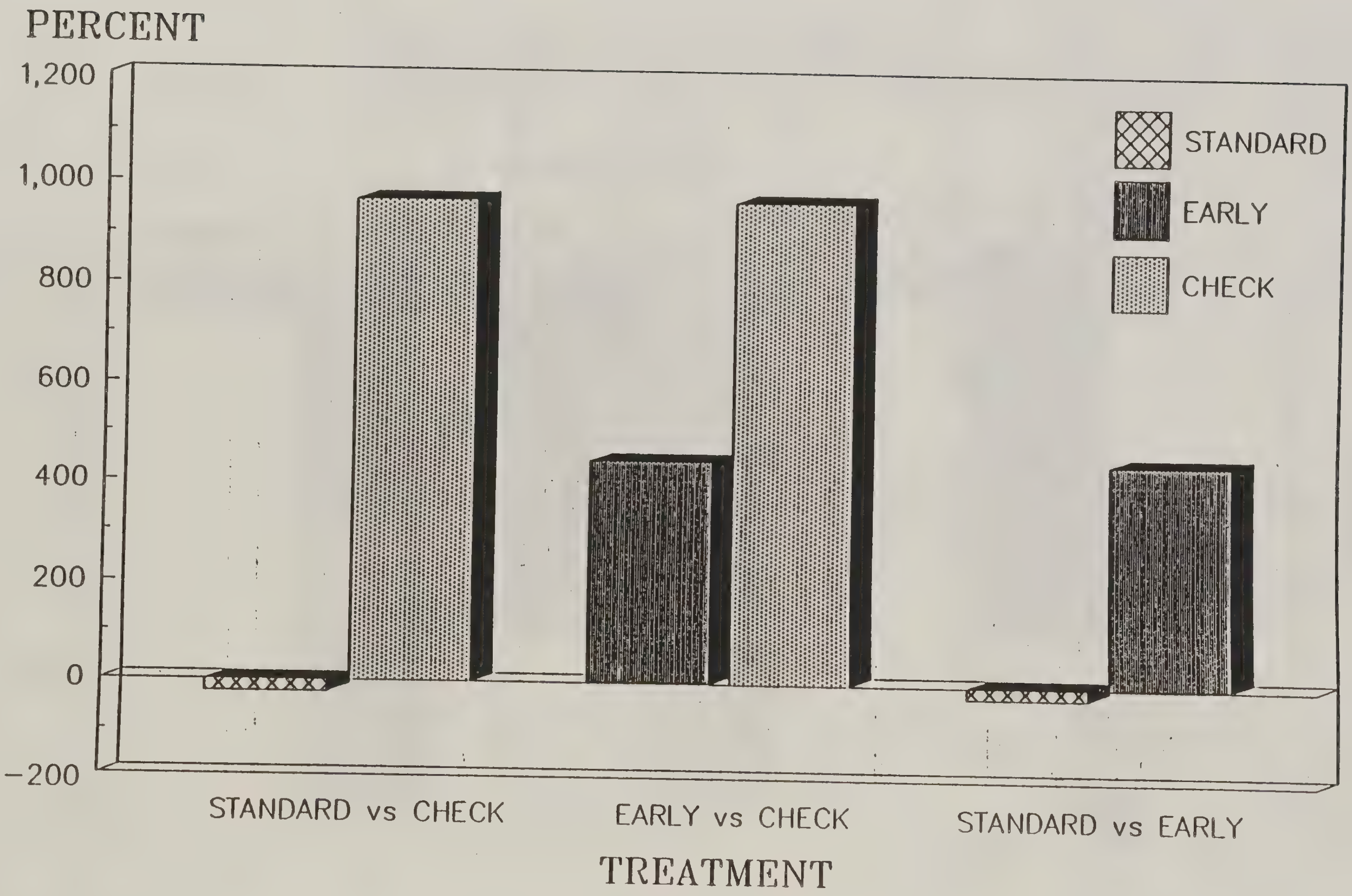

Figure 2. -- Comparison of percent change in egg masses per acre between treatments. 1988 Early Dimilin Evaluation.

Field Studies With Low Volume Applications of Dimilin 2F (Special) 1989

Field Studies with Low Volume Applications
of Dimilin 2F (Special)
1989

by

W. McLane, J. Finney, B. Tanner, and P. Bohne

Table 1. Percent population change based on pre- and post-spray egg mass counts

Treatment	Pre-spray EM/acre	Post-spray EM/acre	Percent change
128 oz.	1,110 [1]	50 [2]	- 95.4
64 oz.	1,101	10	- 99.0
32 oz.	1,193	4	- 99..6
16 oz.	1,103	66	- 94
Control	894	5,459	+510.6

Table 2. An estimate of the Dimilin spray (micrograms/cm^2 AI) found on oak foliage when aerially applied at 128 and 32 fl. oz. per acre

Rate	N	Tree section	Microgram/cm^2 Mean(a)	Log 10 Mean(b)	Error
128 fl. oz./A	500	both	0.00912	-2.04	0.04
	250	lower	0.00676	-2.17	0.06
	250	upper	0.01202	-1.92	0.05
32 fl. oz./A	500	both	0.01413	-1.85	0.04
	250	lower	0.01148	-1.94	0.07
	250	upper	0.01698	-1.77	0.07

(a) Calculated using the geometric mean method.

(b) Transformed from Log10 mean value.

Numerous laboratory and limited field studies indicate that Dimilin can be successfully applied at dosages lower than those presently used [(McLane and Finney) and (Herbaugh, McLane and Finney)]. With increasing concerns of environmentalists and the general public about the use of all pesticides, it

is important that we use the smallest effective amount possible. Dimilin 25W is presently used at .03 lbs. AI/gallon/acre.

During 1989 field studies continued with ULV applications of Dimilin 2F (Special) as well as lower dosages of each formulation.

Table 3. Treatments for 1989 Dimilin ULV and low dosage studies

Formulation	Dosage/rate	Acres treated
Dimilin 25W	.03 lbs.AI/128oz/acre	200
Dimilin 25W	.015lbs.AI/128oz/acre	200
Dimilin 2F (SP)	.03 lbs.AI/32oz/acre	200
Dimilin 2F (SP)	.015lbs.AI/32oz/acre	200
Dimilin 2F (SP)	.03 lbs.AI/16oz/acre	200
Dimilin 4F	.03 lbs.AI/128oz/acre	400
Control	--	200

Approximately 400 acres were treated with a Dimilin 4F (flowable) formulation.

Methods and Techniques

Twenty-four woodland plots were established on state game lands in Elk and Jefferson Counties, Pennsylvania. Plots were square and 50 acres in size and located a minimum of 400 feet apart. Boundary lines were surveyed and marked with fluorescent orange tape and each corner tree was marked with double fluorescent orange tape and a tag identifying corners and plot numbers. Plots were located so that there would be a maximum number of corners on or near roadways.

Treatment evaluation consisted of pre- and post-spray egg mass counts, egg hatchability tests, post-spray larvae counts under burlap, defoliation observations and residue work using wash-off and HPLC techniques.

Within the center 10 acres of each plot, 10 prism points were established. 5 points on 2 parallel lines. During March and early April, pre-spray egg mass numbers were recorded on each prism tree and within each fixed radius plot. Prism tree DBH was also recorded. A limited number of egg masses were collected from the field and returned to the laboratory for hatchability tests. Hatch was uniform at 80> percent with little virus load.

Burlap was placed on 5 oak trees at random in the center 10 acres of one plot in each treatment. Three counts were made on the number of gypsy moth larvae under each band following treatment. After each reading, all larvae were removed from under the burlaps.

At peak defoliation time (early July), a survey was conducted from the ground. Total defoliation of all oak species was estimated at each prism point within each experimental plot.

Within 4 hours of treatment, foliage was collected in one plot each of the 128, 32 and 16 ounce treatments. Foliage was collected from the top, mid- and lower crown of 10 trees within each plot. From each tree and each location within the crown, foliage was collected at each cardinal direction.

Ten leaves were selected from HPLC work and 10 for wash-off work at Pennsylvania State University.

All foliage was shot out of the trees using a 12-gauge shotgun with 2.75 and 3 inch shells. This technique worked very well except for some black and blue shoulders.

Foliage was shipped to the USDA, APHIS National Monitoring Laboratory at

Gulfport, Mississippi for HPLC analysis. Ms. J. Finney, assisted by Dr. Yendol's staff at Pennsylvania State University, did the wash-off.

An APHIS Cessna Ag-truck aircraft was used to apply all treatments. Applications of 128 ounces per acre were made with 8004 flat fan nozzles with lesser amounts applied through 8002 nozzle tips. The aircraft sprayed a 75-foot swath at 120 mph, approximately 50 feet above the target foliage. Boom pressure was 40 psi. Screens of 50 mesh size were used in each nozzle and in the nurse tank.

The aircraft was calibrated over the first spray plot. Mixing was done in a nurse tank and then pumped into the aircraft. Additions for the Dimilin 2F (Special) were added as a tank mix at the base of operations, DuBois Airport. A ________ timer was used to aid calibration.

All applications were made in the morning hours between 6:00-12:00 AM starting 6/1 and 6/3. Temperatures ranged between 50° - 75°F. Application was terminated when winds exceeded 6 mph. Humidity was in the 40-60 percent range.

Gypsy moth size during the treatment time ranged, the majority being early to late 2nd instar larvae. In general, foliage was expanded 40-60 percent.

Results

All treatments gave excellent gypsy moth population reduction based on egg mass counts. The ULV and low dosage treatment were as effective as the standard of Dimilin 25W. However, it was unfortunate that a population reduction also occurred in the untreated controls and therefore these data may be questionable at best.

We had problems mixing the emulsifiers and additives with the Dimilin 2F formulation in the field. Although we did use a considerable amount of

emulsifier, the mix was not good. The formulation needs to be worked on to correct this problem.

Once the material was in the aircraft, it dispersed fine and cause no blockage of nozzles or screens.

A significant amount of rainfall occurred during the 3-day period following treatments. However, this should have had no effect on the efficacy (McLane and Finney).

Foliage protection was excellent in all treatments and larvae under burlap were greatly reduced in all treatment plots.

As was the case in our 1988 study (Yendol ----), the HPLC analysis recovered nearly as much Dimilin 2f (Spezial) in the 32 ounce/acre treatment as Dimilin 25W in the 128 ounce/acre application. This again demonstrates the excessive evaporation taking place with the Dimilin 25W formulation. The Dimilin 2F (Special) at 16 ounces/acre had less material on foliage than the Dimilin 25W treatment at 128 ounces per acre.

Most Dimilin 25W was found high up in the tree (twice that found in the mid- or lower crown), whereas the Dimilin 2F at 16 and 32 ounces was very uniform in its deposit from top to lower crown. This more than likely was due to the finer droplets produced by the 8002 flat fan tips being able to penetrate the foliage canopy more efficiently. Most larger droplets produced by the 8004 flat fan tips stayed near the top of the tree crown.

The wash-off tests conducted at Pennsylvania State also identify most of the Dimilin 25W at 128 ounces per acre as being high up in the tree and the Dimilin 2F (Special) as being more uniform throughout the tree.

Based on 1988 and this year's data, it is evident that ULV applications of Dimilin 2F (Special) can be just as effective as the standard formulation now

being used at 128 ounces per acre. It is therefore time to conduct a pilot test with Dimilin 2F (Special) so that operational programs can use it in the near future. However, before this can happen, the formulation has to be improved so that mixing does not have to take place in the field. If this requires registration, it must be addressed as soon as possible.

The Dimilin 4F formulation performed very well based on efficacy, mixing and handling. This is a formulation that should be registered for use as the Dimilin 25W is presently used. It could also be used as a Special for ULV applications.

Again, as in , low dosages were very effective. It is important that this work continue so that lower dosages can someday be used to ease the environmental concerns. If lower dosages are not available for use in the future, we may not have Dimilin to use at all.

Table 4. Percent population change based on pre- and post-spray egg mass counts

Formulation	Dosage/rate lbs.AI/oz/acre	Pre [1] Egg masses/acre	Post [1] Egg masses/acre	Percent change
Dimilin 25W	.03/128oz	635	14	- 97.7
Dimilin 25W	.015/128oz	544	12	- 97.8
Dimilin 2F(SP)	.03/32oz	801	3	- 99.1
Dimilin 2F(SP)	.015/32oz	1902	0	-100
Dimilin 2F(SP)	.03/16oz	705	1	- 99.8
Dimilin 4F	.03/128oz	946	11	-98.8
Control		536 [2]	369 [2]	-31.1

1/ Average of 4 spray plots

2/ Average of 5 untreated plots

Table 5. Average number of larvae under burlaps after spraying and percent defoliation at peak defoliation time

Formulation	Dosage/rate lbs.AI/oz/acre	Larvae under burlap	Percent defoliation
Dimilin 25W	.03/128oz	1.5	0-10
Dimilin 25W	.015/128oz	0	0-10
Dimilin 2F(SP)	.03/32oz	.33	0-10
Dimilin 2F(SP)	.015/32oz	0	0-10
Dimilin 2F(SP)	.03/16oz	.66	0-10
Dimilin 4F	.03/128oz	--	0-10
Control	--	6.88	20-30

Table 6. Rainfall during and after application time

Date	Inches rain
6/1	0.48
6/2	0.0
6/3	0.22
6/4	0.33
6/5	0.46
6/6	0.05
6/7	0.39
6/8	0.01
6/9	0.07
6/10	0.07

Table 7. Average ppm of Dimilin recovered from 10 trees at various canopy locations

Formulation	Dosage/rate lbs.AI/oz/acre	High	Medium	Low	Average 3 locations
Dimilin 25W	.03/128oz	2.047	1.092	0.931	1.356
Dimilin 2F (SP)	.03/32oz	2.3	2.01	1.829	2.046
Dimilin 2F (SP)	.03/16oz	.846	.838	1.045	.909
Control	--	<.5	<.5	<.5	<.5

Table 8. Average fluorescence of dye recovered from 10 trees at various canopy locations

Formulation	Dosage/rate lbs.AI/oz/acre	High	Medium	Low	Average 3 locations
Dimilin 25W	.03/128oz	364	332	248	315
Dimilin 2F(SP)	.03/32oz	378	424	428	410
Dimilin 2F(SP)	.03/16oz	253	285	307	282
Control	--	91	113	110	105